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Abstract

This paper addresses two questions. First, when and to what extent did capital markets integrate north and south of the Alps? Second, how mobile was capital? Analysing a unique new dataset on pre-modern urban annuities, we find that northern markets were consistently better integrated than Italian markets. Long-term integration was driven by initially peripheral places in the Netherlands and Upper Germany integrating with the rest of the Holy Roman Empire where the distance and volume of inter-urban investments grew primarily in the sixteenth century. The institutions of the Empire contributed to stronger market integration north of the Alps.

Introduction

Historians of premodern Europe agree that Central Europe was financially far less advanced than the Italian city states that were leading in financial innovation at least up to the seventeenth century. It was in Italy where modern commercial loans emerged first and governments first developed a system of municipally funded debts (Day 1987; Sylla 2002: 82; Munro 2003, pp. 514-16; Denzel 2008, pp. 51-53). The present article compares the integration of capital markets in this financially sophisticated region with markets in Central Europe. The focus is on one specific type of market for capital, i.e. the market for urban annuities which is particularly well documented.

Annuity markets have been studied from a variety of perspectives. One strand of the historiography is concerned with the social background of the buyers of annuities and the role

such instruments played in constitutional development and public finance (Gabrielsson 1971; Sprandel 1971; Rosen 1978; Gilomen 1982; Alter and Riley 1986; Brown *et al.* 2001; Tracy 2003; Poitras 2006; Zuiderduijn 2009; van der Heijden 2006). This literature explores an issue closely linked to our present concerns: the geographical origin of investors. Several authors stress that in Italy, unlike Northern Europe, most urban bonds were owned by locals (Molho 1995, pp. 107-09; Pezzolo 2005, pp. 156-58; Zuiderduijn 2009, pp. 262-64).

Another strand of the literature is primarily concerned with the factors determining the *level* of interest rates and its change over time. Within this particular historiography one can distinguish two lines of argument: Some authors highlight how political systems like feudalism (Chilosi 2014) or institutions such as representative assemblies (Stasavage 2011, pp. 154-55) influenced capital costs; others emphasize the role played by the supply of capital and the development of secondary markets (Epstein 2000, pp. 19-24; Gelderblom and Jonker 2004, 2011).

There is a third, and growing, strand of research that speaks directly to the issue of this paper, namely capital market *integration*.

¹ Luciano Pezzolo and Guiseppe Tattara (2008), for example, examined how the exchange fairs of Bisenzone around 1600 fostered inter-urban arbitrage and financial market integration. Genoese bankers used the fairs to raise money for the Spanish crown, developing financial techniques and a network that reduced the risk of lending to fund Spanish long-term debts via short-term loans. By contrast, Carlos Álvarez-Nogal's (2009) study of urban public debts in Castile found no evidence of integration across the annuity markets of Burgos, Cadiz and Murcia between 1540 and 1740. Most recently Wolfgang Keller *et al.* (2016) drawing on interest rates imputed from grain storage data, compared Chinese and British capital markets in the late eighteenth and nineteenth centuries. They found not only that the costs of capital in

Britain were on average lower than in China, but also that British capital markets were better integrated.

In this paper we measure and document the extent, timing and spatial spread of premodern capital market integration. We employ Maurice Obstfeld and Alan Taylor's (2004) well-trying approach and examine, first, patterns of convergence in interest rates (here: yields of urban annuities) and, second, inter-city capital flows. The study draws on a new, unique dataset of about 29,000 individual interest rate observations from more than 100 cities over a period of almost 500 years. We consider markets from across the Holy Roman Empire north of the Alps and from Italy.² The earliest observations in the sample are from the fourteenth century, with the analysis closing at around 1800. We ask to what extent urban capital markets integrated in the *long run* and how *mobile* capital was between cities.

The interest rates used here derive from the prices of life and heritable annuities sold by town councils. In the Empire, these instruments were secured against real estate owned by the town or, more rarely, against its regular revenues. Buyers of such securities paid a sum of money in return for an annual interest payment. If a town defaulted, the courts protected the annuity holders' right to seize the real estate that served as collateral. Life annuities and heritable annuities differed in that life annuities were typically paid until the purchaser died. By contrast, heritable annuities were - in principle, at least - paid in eternity and could be bequeathed (Baum 1985, p. 25).

A few surviving accounts allow gauging the importance of such urban debts. In Nuremberg in the 1430s, for example, newly raised loans reached up to 55 per cent of the total annual income of the town. For fifteenth-century Munich values of up to 25 per cent, and for sixteenth-century Schwäbisch Hall values up to 62 per cent have been calculated (Fuhrmann 2003, pp. 4-12). By the end of the early modern age, most Free Imperial Cities were heavily indebted. Those in South Germany commonly had to earmark more than half of

their revenues for servicing their liabilities (Quarthal 1991, p. 223). Territorial towns, i.e. those under the authority of a prince, depended less on deficit finance, as loans had to be increasingly approved by their rulers from about the mid-seventeenth century (Kern, 2000; Fuhrmann 2014, pp.188, 195).

Italian annuities developed in two phases. From the twelfth to the fifteenth centuries, many securities, known as *forced loans*, were forcibly allocated to the local well-to-do, with Genoa, Florence and Venice among the cities that issued such securities (Pezzolo 2005). From the sixteenth century, urban debts spread across the peninsula and voluntary lending became the norm (Pezzolo 1995). Urban authorities typically allocated specific revenues to servicing their debts. While fiscal decentralisation was as common in Italy as in the Empire, estimating the size of debt is possible for capital cities where urban and regional state finances overlapped. For example, in about 1500 the Republic of Genoa's stock of debt was 35 times the size of its annual revenues. This was an extreme case. In Florence and Venice the corresponding figure was about one fourth. In the seventeenth century, other cities caught up with the financial pioneers, with their debts rapidly expanding in the face of stagnating revenues. Thus, by 1700, Venice and Papal Rome had accumulated a stock of debt equivalent to, respectively, 15 and 20 times annual revenues. These were very high debts indeed with the stock of *per capita* debt equivalent to the annual costs of feeding, clothing and housing around two people. Those of Naples and Milan were not far behind (cf. Chilosi 2014, pp. 897-98).

Comparing the Empire and Italy is exceptionally fruitful. Italy gave birth to a large number of financial innovations that until the seventeenth century earned it the reputation as the financially most advanced part of Europe. By contrast, the historiography regards Germany as backward (de Vries 1976, p. 221; Denzel 2008, pp. 105-06, 121). Politically, the Empire and Italy give a superficially similar impression of having been fragmented.

However, unlike Italy, the Empire had an overarching constitution. This constitution applied neither to the Imperial fiefs in Italy nor to the rest of the peninsula (Schmidt 2011, p. 46).

Moreover, in Italy, alternative supra-urban organizations such as the Lombard League were defunct already by the fourteenth century, whereas the Empire's constitution continued to be supplemented by urban and other leagues far into the early modern age (Spruyt 1994, pp.109-11; Distler 2006).

Our results suggest that over the whole period markets were better integrated north of the Alps than in financially more developed Italy. Indeed, in the early modern era, interest rate differentials narrowed only in the Empire. Further, north of the Alps both the distance and volume of investments grew at the same time as the yield differentials between distant markets declined. In the Empire, capital markets had a number of centres. The long-term erosion of interest differentials between them was mainly driven by convergence of initially peripheral markets in the Netherlands and Upper Germany with the rest.

Sources and Data

Most data used here were collected from a large number of archives which are listed in detail in Online Appendix A. In Table 1 we delineate the main types of sources. Letters contain the most comprehensive information. They generally give the contract, and margin and dorsal notes sometimes give additional information, e.g. on later changes and redemptions. Ledgers, including all books and documents kept to administer urban annuities, are the most heterogeneous type of source. At best, they record all sold annuities, briefly listing the conditions of the contract, as well as transfers, conversions and redemptions (e.g. the Nuremberg ledgers). However, most ledgers contain only partial information on the contract and its history. Pay-out ledgers, for example, sometimes omit the original interest rate but record a later conversion. In a few cases, we had to infer the date of the conversion by

checking whether different types of sources were consistent with each other. Urban accounts record sold annuities as part of the revenues of a town. As several branches of urban administration could sell annuities, the main accounts (that we use predominantly) do not necessarily document all sales in a year. They only summarise the contracts, stating the name of the buyer, the capital and pay-out or interest rate, sometimes the date, but mostly only the fiscal year. In such cases we assumed that the annuity was sold in the first calendar year (e.g. when the fiscal year was 1525/26, we assumed the sale to have taken place in 1525). Data from edicts that reported the official rate and (in varying levels of detail) the conditions of purchase were included from Northern France, the Netherlands and Italy only.

< Table 1 about here >

For Germany, the data come from *actual* sales of annuities – i.e. we exclude interest rates stipulated in edicts or similar sources. The data refer to primary yields which are much better documented than those on secondary markets. Where evidence on interest rates in secondary markets exists, it shows yields close to those on primary markets.³ Note that German urban authorities sold annuities continuously, that is not only in times of fiscal need or when there was a particularly strong demand by prospective buyers. For non-German markets in the Empire, for example Dutch or Flemish, the analysis includes rates determined by law and published in edicts. In Lille and Amsterdam, where it is possible to compare such rates with those paid on the primary market, both match.⁴

The data for Italy come in two forms. First, for the period before 1493 we use secondary market rates on *forced loans*, which until this point dominated urban debts. As such forced loans were riskier than those purchased voluntarily, differentials between forced loans' rates and their secondary market rates were far larger than in the case of rents issued on 'open' primary markets (Chilosi 2014, pp. 889-91, 2015, Section 5). Second, from the sixteenth century onwards, i.e. after forced loans had fallen out of use and 'open' primary markets

emerged, our Italian interest rate data mainly refer to official rather than market rates.

However, where primary market rates are available the official rates were typically close to them. Since market yields tended to magnify differences in the return between safe and risky securities (Chilosi 2014, p. 892), using mostly official rates biases the analysis *against* our finding below that Italian markets were relatively weakly integrated.⁵

With few exceptions, which we exclude from the analysis, the prices of urban life and heritable annuities were not related to the age or health or any other biological characteristics of the buyers or those in whose name an annuity was taken out. Hence, the ratio between the yearly pay-out and the purchase price equals the interest rate.⁶ The analysis uses nominal rather than real (i.e. deflated) rates for three reasons. First, the available evidence suggests that differences in *long-run* inflation rates between markets were small (Allen 2001, online database;⁷ Malanima 2002, Appendix). In the given context, it is these long-term rates that matter since the focus here is on securities with long-term maturities. Second, likely small differences between local inflation rates can be estimated only imprecisely because there are few cities where sufficiently detailed price indices are available. Third, and most importantly, the information needed to anticipate price changes over the *long term* was not readily available to the investors (Gilomen 1984, p. 195). When deciding where and at what interest to invest their capital, pre-modern investors had little choice but to use nominal rather than real rates (Chilosi 2014, p. 903).

Sometimes authorities taxed annuities or offered benefits to buyers. Within the Empire, it is only in Nuremberg and Brunswick and in selected periods that the evidence allows estimating what difference this made.⁸ We compare 186 rates on such annuities from between 1396 and 1590 and found that tax-free rates differed on average only by 0.37 percentage points from others. In Italy, some of the forced loans in Venice and annuities sold in Genoa

were taxed. Generally, we used the return net of tax when available or else we assume that the pay-out was not affected by taxes or benefits.

The difference between yields on equally risky securities cannot exceed inter-urban transaction costs for long periods of time because arbitrage will trigger adjustment, with capital flowing from where it is relatively cheap to where it is relatively costly. In consequence, differences in yields shrink until they are at the level of or lower than transaction costs. However, these costs are not the only determinant of yield differentials. Similar conditions of supply and demand can produce similar interest rates even in the absence of arbitrage. We therefore also analyse inter-urban capital flows. Such flows highlight that cities within the Empire were linked through fairly dense ties. Thus, the twelve best-covered cities in the sample show a network density (the proportion of actual to potential links) of 42 per cent.⁹ This is a much higher value than that for the mid-eighteenth century European money market (12 per cent, Flandreau *et al.* 2009, p. 160) and roughly matches that existing between nation-states in today's bond market (57 per cent, Schiavo *et al.* 2010, p. 392).

Moreover, inter-urban differences in yields may reflect not only transaction costs between markets but also differences in risk of default (non-payment or falling into arrears). However, if cities discriminated between domestic and 'foreign' (in its premodern sense, cf. Schultze 1908, p. 77) investors, exposing them to *different* risks, as was often the case in Italy, then the differences between their risk premia did indeed become part of inter-urban transaction costs, thus affecting the measured extent of integration.

The analysis uses yearly means as there are only few cases where the date of a transaction can be identified with greater than yearly precision. Altogether, there are 5,040 yearly means for heritable and 1,520 for life annuities. While in the very early stages of development life annuities were the more important instrument, over time they became less

popular. Possibly this reflected a learning process on the part of the sellers: Heritable annuities did not require the authorities to periodically check that the beneficiary was still alive and, therefore, implied lower administrative costs than life annuities. Further, life annuities were potentially bought on behalf of young children, implying a higher return to the beneficiaries and higher costs to the issuer. The data from the Empire allow analysing differentials between local yields from the mid-fourteenth century. For Italy, where secondary market yields on forced loans are available only for Florence, Genoa and Venice, the number of pre-sixteenth-century observations is so small that for this period the analysis cannot be more than exploratory. Up to the mid-seventeenth century the number of observations increases. There are fewer surviving data from the Empire thereafter. Following the Peace of Westphalia, many cities lost their fiscal autonomy and ceased raising debts. Figure 1 (a and b) shows the geographical distribution of observations of yearly means.

<Figure 1 about here>

The interest rates are from 101 cities, 72 of which are located north of the Alps and 30 in Italy.¹⁰ While the coverage is uneven, our archival research extends far beyond what was available in previous studies of urban annuities or premodern financial integration in Europe. The north of the Empire is particularly well-covered, as are Central and Northern Italy. Figure 1a also shows that life annuities were clearly much less common in Italy than north of the Alps. For this reason, life annuities are examined only for the whole sample and the northern sub-sample.

Figure 2 shows how the nominal yield on heritable annuities, including forced loans in Italy before 1493, developed north and south of the Alps.¹¹

<Figure 2 about here>

In the long run nominal interest rates in the Empire declined, though in contrast to what prior research implied (Homer and Sylla 2005, pp. 135, 153, 176), their fall was not steady. Two periods of decline stand out: the early fourteenth to the early fifteenth and the second half of the seventeenth centuries. In between and after these periods rates stagnated. Italian forced loans, whose yields on the secondary market had often been exceptionally high and volatile, disappeared around 1500. Thereafter, Italian yields on securities sold on the primary market fell continuously to the late eighteenth century. Despite the country's precocious financial development in the late Middle Ages, yields in Italy were initially much higher than north of the Alps. However, they fell to values lower than those in the Empire in the mid-seventeenth century and from then on stayed slightly lower until the end of the period analysed here.

Integration Trends: North versus South

The coefficient of variation is a standard measure of price or interest rate dispersion: The smaller it is, the more alike were local interest rates and the greater the level of integration. However, as the coefficient is affected by changes in the sample's composition of markets, gaps in the interest rate series may introduce a bias. To address this issue, we use city fixed effects and regress the absolute value of the natural logarithm of the ratio between the interest rate in each market and the average interest rate on a time trend:

$$abs \left[\ln \left(\frac{i_{it}}{\bar{l}_t} \right) \right] = \alpha_i + \beta year + u_{it} \quad (1)$$

where *abs* stands for absolute value, *ln* is the natural logarithm operator, *i_{it}* is the interest rate in place *i* and year *t*, \bar{l}_t is the sample cross-sectional average interest rate in year *t*, α_i is a place-specific fixed effect, β is the yearly rate of change and *u_{it}* is an error term.

The results (Table 2, columns 3 and 4) show that the differentials were much larger in Italy than in the Empire both at the beginning and at the end of our period. This holds irrespective

of whether forced loans traded on the secondary market in late medieval Italy are included. Only if such forced loans *are* included do Italian markets display a significant trend in long-run interest rate convergence. In other words, from the sixteenth century, when a primary market in annuities developed, interest rates in Italy did not converge any further. By contrast, the results on yearly rates of change and the associated cumulated changes indicate a long-term advance in integration north of the Alps (Table 2, columns 5 and 6).

<Table 2 about here>

Such long-term trends may obscure non-linear patterns of convergence and divergence. To examine such patterns, we use again fixed effects panel analysis of the dispersion around the mean, but now with 10-year dummies rather than a time trend (cf. Bateman 2011):

$$abs \left[\ln \left(\frac{i_{it}}{\bar{i}_t} \right) \right] = \alpha_i + \sum_{d=1350-1359}^{1790-1799} \beta_d Decade_d + u_{it} \quad (2)$$

where β_d denotes the rate of change in the gap between the local and the sample average interest rate in decade d , otherwise the notation is as in equation (1).

As the analysis requires a large sample, we consider heritable annuities only (Figure 3).¹²

<Figure 3 about here>

Interest rates in Italy were much more dispersed than in the Empire. For the late Middle Ages, this appears to have been due to the dominance of forced loans. Once an open market for annuities had developed, interest differentials moved closer to those in the Empire. However, not only were they still larger than north of the Alps, they also fluctuated far more strongly throughout the whole period under review. In terms of dispersion, northern capital markets were clearly better integrated than those in the supposedly more developed south.

Recent research has shown that in Italy differences between local risk-levels helped keeping differentials large. Apart from forced loans in the late Middle Ages, securities issued in the early modern Spanish territories (Milan, Naples and Sicily) were particularly risky (Chilosi 2014, pp. 890, 900). Still, even if observations from the Spanish possessions are excluded, differentials in Italy remain wider than in the Empire. The difference is especially startling considering that the average distance of 286 kilometres between between the Italian cities is smaller than that between the sample cities north of the Alps (379 kilometres).

Examining where the owners of the debts lived confirms that the Empire was better integrated than Italy. In the Middle Ages, securities issued by Italian city-states were mostly held locally. Capital flows between Italian cities did intensify in the early modern era, but most bonds still remained in local hands. The Italian city where foreigners owned the greatest share of the debt was probably Venice. By the later seventeenth century, about one-third of its debt was owned by people from outside the Republic, mostly from Genoa (Felloni 1971, *passim*; Masini 2007, pp. 205-07; Stumpo 2007, pp. 149-51). By contrast, in Flanders, Holland and Germany a large part of the urban debt, half or more, was owned by non-locals even at the very beginning of the period under review (Fryde and Fryde 1963, pp. 528-30, 540, 545, 547, 553; Munro 2007, pp. 10, 21-22; Zuijderduin 2009, pp. 178-79). In the Empire inter-urban capital flows further intensified over time.

Capital Flows and Distance

How large were the distances over which investors in the Empire placed their capital, and how did these distances and the invested sums change over time? For 52 markets north of the Alps, the sources contain information on the origin of investors from other places. After excluding trivial links with markets within their hinterland,¹³ we retain 4,541 observations of inter-city investments across 915 city pairs. Comparing investments from different periods

requires converting the invested sums into a constant measure. We use the cost of a yearly ‘respectable’ consumption basket.¹⁴ Excluding those cases where missing capital or coinage data prevented conversion, the analysis builds on 4,095 investment observations. As a first step to assess how capital flows evolved, we investigate trends in the distance and volume of investments. As before, to control for changes in the composition of the sample over time we run fixed-effect panel regressions of the natural logarithm of the yearly means against a time-trend:

$$\ln(y_{it}) = \alpha_i + \beta year + u_{it} \quad (3)$$

where y_{it} is the yearly mean of the dependent variable of interest (capital invested or distance between places) in place i in year t , α_i is an importer-specific fixed effect and β is the yearly rate of change; u_{it} is an error term.

<Table 3 about here>

In the long run the distance and volume of investments grew significantly: With distance increasing from 47 to 116 kilometres and capital invested rising from 31 to 87 consumption baskets (Table 3, columns 5 and 6), the average values are more than twice as large at the end of the period as at its beginning. This supports the finding that the Empire’s capital markets became increasingly integrated. While most investors placed their capital relatively close to home, the sums in question were large. On average and at the prevailing interest rates (see Figure 2), the yearly return on the sums invested in heritable annuities was sufficient to feed, clothe and house about three people, i.e. a small family.

To gauge *when* the distance and volume of inter-city investments grew, we regress their means against 50-years dummies over the period 1350-1699 (there are not enough eighteenth century observations to produce reliable estimates):¹⁵

$$\ln(y_{it}) = \alpha_i + \sum_{f=1350-1399}^{1650-1699} \beta_f \text{Fifty}_f + u_{it} \quad (4)$$

where β_f is the rate of change in the dependent variable of interest (y_{it} : capital invested or distance between places) in the fifty-year period f , otherwise the notation is as in equation (3).

The trends obtained are compared with the *inverted* trend of the interest-rate differentials (heritable annuities) within the Empire, where a higher value signals increased capital market integration (Figure 4).

<Figure 4 about here>

From the early sixteenth to the mid-seventeenth century, the increase in integration (here shown as a rise in the inverted log interest-rate ratio, right hand axis) was closely associated with growth in both invested sums and distance of investments (left hand axis). In the second half of the seventeenth century, however, the capital figures and the differentials suggest disintegration while the distance measure does not. This is probably an outcome of the spatially uneven effects of the Thirty-Years-War. The demand for capital grew relative to its supply as the need to finance post-war reconstruction led to a decline in sums invested in the annuity market. At the same time, distances over which capital was placed continued to increase as urban authorities - in the face of diminished local supply - were seeking to attract capital from farther away, i.e. areas less affected by the war.¹⁶

The question is how the reach of the market expanded over the long term. We use 1520 as a suitable cut-off point because it marks the start of the sixteenth-century spurt in interest rate convergence and allows splitting the sample into two similarly-sized sub-samples.¹⁷ Both before and after 1520, most capital was invested within a radius of 200 kilometres and sums rarely exceeded 200 consumption baskets, which corresponds, for example, to 3,411 Lübeck marks in 1520. However, the reach of the market increased at the *high* margin: from the

sixteenth century, investment gained previously unattained sizes and distances which drove up the *average* values of investments.¹⁸

Did *long-distance* investment also drive interest rate convergence?¹⁹ Since we find that the frequency of inter-city investments drops sharply beyond c. 200 kilometres, this makes an appropriate cut-off point for comparing long-term trends. We use fixed effects panel regression of pairwise differentials on time:

$$abs \left[\ln \left(\frac{i_{it}}{i_{jt}} \right) \right] = \alpha_i + \beta year + u_{it} \quad (5)$$

where the notation is equivalent to that of equation (1).

Table 4 shows the results.

<Table 4 about here>

The highly significant yearly rates of change and associated cumulated changes (Table 4, columns 3 and 6) indicate that long-distance convergence played the key role, advancing almost twice as fast as local convergence. By the end of the period, pairwise differentials between distant places were on average almost as small as those between close markets (Table 4, column 5).

To show *when* differentials between more distant places shrank, we compare the pairwise differentials across distance groups over consecutive 10-year periods and compute panel trends:

$$abs \left[\ln \left(\frac{i_{it}}{i_{jt}} \right) \right] = \alpha_i + \sum_{d=1320-1329}^{1800-1809} \beta_d Decade_d + u_{it} \quad (6)$$

where the notation is equivalent to that in equation (2).

<Figure 5 about here>

Figure 5 shows the estimated trend values. The results are fully in line with those of the earlier analysis. *Short-distance* convergence (<200km) advanced significantly from the early fifteenth to the mid-sixteenth centuries. *Long-distance* convergence began several decades later: Differentials between places over 200 kilometres apart declined from about 1500 to 1630. Since the early seventeenth century, interest rates differentials varied little between both distance groups, i.e. by about 10 to 15 per cent on average. In other words, given costs of capital of about 4 per cent, we are looking at interest rate differentials of half a percentage point, which suggests a capital market that was well-integrated by any standard.

Regional Integration in the Empire

How clustered were capital markets north of the Alps – or which cities were linked by particularly strong capital flows? We investigate these questions first and then use the insights thus gained to divide our sample and study how capital market integration evolved *between* and *within* clusters in the Empire.

To identify clusters of cities, we rely on the model developed by Michael Schweinberger and Tom Snijders (2003). Their technique allows detecting such clusters across various levels of capital flow intensity, defined in a descending order where level 1 is the highest. The likelihood that all the actual links between cities in the sample are recorded does increase with the number of observations from each capital-importing city. However, the fewer well-recorded cities are included, the smaller is the geographical area covered. Concentrating on the 28 cities with at least 10 observations on capital imports is a compromise between the desire to include as many markets and as wide an area as possible and the need to focus on those cities which are sufficiently well-documented. Sample bias is addressed by estimating the capital flows that would be observed if all the linked cities had the same number of

observations on capital imports. The measure of capital flow intensity is an index that ranges from 0 to 1 (see Online Appendix B for technical details). Figure 6 shows the clusters.

< Figure 6 about here >

Capital flows were exceptionally strong between Lübeck and Lüneburg. These are the only cities where we observe the highest level of capital flow intensity. Already at the next lower level, intensity drops by two thirds (from 1 to 0.364). At this level, we find two clusters: one is an expanded group in Lower Saxony (Hamburg and Brunswick, together with Lübeck and Lüneburg); the other is the Frankfurt-Mainz pair in Hesse. Expected capital flows at the third level remain relatively high (0.15). Here, Bremen, Hanover and Hildesheim join the cluster in Lower Saxony. Worms becomes part of the Hesse cluster that at Level 2 was formed by Frankfurt and Mainz only. Moreover, at the third level a Breisgau cluster (Basel, Colmar and Freiburg), an Upper Germany cluster (Augsburg, Munich, Nuremberg), a cluster in Upper Saxony (Erfurt, Leipzig, Halle) and another in Westphalia (Münster, Wesel) emerge. The fourth level, not shown in Figure 6, contains all 28 cities examined but is characterised by very weak capital flows (0.009).²⁰

These findings agree with our results on the role of distance. All cities with strong capital flow links between them were geographically relatively close, with clusters developing around financial or commercial centres such as Frankfurt, Leipzig, Nuremberg and Lübeck.²¹ Outside these clusters, capital flows tended to be much smaller. One reason for this difference may be information flows that, though not directly related to annuities, made for easier inter-city investment. The relation between Lüneburg – a centre of the production of salt – and Lübeck – from where the salt was distributed across the Baltic – is a case in point: The cluster in Lower Saxony reached particularly high levels of capital flows and was significantly wider than others at the same level of network intensity.²²

The question now is to what extent interest rates converged within and between clusters. In addition to the cities in the clusters already identified, we draw on interest rate observations from markets that could not be included in the *endogenous* cluster identification because of insufficient capital flow data. Most of these cities were allocated *exogenously* to one of the endogenously identified clusters on the grounds of their proximity. The exceptions are cities from the Netherlands and Northern France whose distance from any of the other clusters is significantly larger than the radius of even the largest cluster. We take these cities to form two separate clusters: The Northern and the Southern Netherlands.²³ Limiting the analysis to the cities identified by endogenous clustering or treating Northern France as a separate group actually strengthens our results. Table 5, columns 3 to 6, shows long-term trends in the dispersion around the mean *within* each cluster (upper panel) and *between* cities in each cluster (lower panel); as before, we rely on city fixed effects estimation (equation 1).

<Table 5 about here>

Our earlier analysis indicates that market integration was more dynamic over long than short distances. This is supported by the finding that the evidence for increases in integration is stronger between than within clusters. The ‘within cluster’-analysis detects very low dispersion – with differences mostly within 10 percentage points – both at the beginning and end of the period studied (upper panel Table 5, columns 4 and 5). In other words, the results suggest that by and large clusters were well-integrated already in the late Middle Ages and remained so. The only and partial exceptions are Lower Saxony, where there is evidence of significant progress over time, and the Southern Netherlands, for which we find disintegration. It is possible that interest rate divergence there reflected the commercial decline of Antwerp after the mouth of the river Scheldt was closed in 1585 (Israel, 1989, p. 30).

Interest rate convergence *between* clusters (lower panel Table 5) mainly concerned regions where differentials were comparatively high at the beginning (column 4). While Westphalia was fairly well integrated from the start, barriers between initially poorly integrated Upper Germany and especially between the Southern and Northern Netherlands and the rest of the Empire apparently eroded over time. To identify *when* this progress took place, the ‘between’-integration panel regression analysis is re-run, using fifty-year dummies instead of a time trend. The results suggest that the timing of each cluster’s integration with the rest of the Empire varied. Thus, Upper Germany saw much progress before the mid-fifteenth century. The Southern Netherlands started off from a similarly high level of segmentation from the rest of the Empire in the second half of the fourteenth century but advanced rapidly between the sixteenth and the first half of the seventeenth centuries. Finally, the main period of convergence of the Northern Netherlands was slightly later, coinciding with the ‘Dutch Golden Age.’²⁴

A Hypothesis: Benefits of Empire

The descriptive analysis of annuity yields suggests a strong contrast between a well integrated Empire and comparatively poorly integrated Italy. While the causal analysis of these differences is a task for future research, we hypothesise that the Empire’s constitutional structure and politics helped inter-urban exchange and yield convergence.

Geography clearly did not favour the regions north of the Alps, large parts of which, unlike Italy, had no direct access to the sea. Further, it is uncontroversial that the Italians pioneered the use of sophisticated financial instruments such the bill of exchange and giro transfers (see, for example, Day 1987, *passim*; Felloni 2008, *passim*; Denzel 2008, pp. 51-53). Thus, neither geography nor the development of financial techniques can account for the edge in capital market integration that the late medieval and early modern Empire enjoyed.

Of course, in the late Middle Ages many Italian communes were much wealthier than the towns north of the Alps and able to draw on more substantial domestic supplies of capital. This probably made them less dependent on loans from outsiders (see Spruyt 1994, pp. 145-46). At the same time, Italian bankers specialised in lending to European princes such as Edward III, rather than to neighbouring towns. Still yield dispersion in Italy remained comparatively high even after the sixteenth century, when the Italian bankers had lost their international prominence, Italian income was no longer particularly high, and urban debts were rapidly expanding (Braudel 1982, pp.169-74; Malanima 2011, p. 188; Chilosi 2014, pp. 897-98).

Financial markets in premodern Europe were often tied to commodity trade. With high information cost and slow communications, trade links and commercial correspondence were highly relevant sources of information on arbitrage opportunities. Also, bonds could sometimes be used as collateral for commercial loans; financial flows triggered by arbitrage counterbalanced trade deficits or surpluses, and secondary markets in public securities gave merchants access to capital in another city when a commercial opportunity arose (de Luca 2007, pp. 140-144; Neal 2015, pp. 42-43; Michie 1998, pp. 10-11; Schubert 1988, pp. 9-12). However, in the given context it is unlikely that trade accounts for the differences in the level of capital market integration between Italy and the Holy Roman Empire. There is no evidence suggesting that commercial flows south of the Alps were *less* intense than in the Empire and could thus account for such differences in integration.²⁵ While at first sight this apparent mismatch between trade flows and interest rate gaps may seem counter-intuitive, it is consistent with the insight that in equilibrium interest rate gaps are determined by transaction costs rather than by market thickness and thus efficiency (cf. Federico 2012, pp. 474-475). Thus, geography, financial techniques and trade seem insufficient to explain the differences in

integration we detect. However, institutions differed markedly between premodern Italy and the Empire, so turning to this factor appears particularly promising.

Italy's fragmented capital markets can be traced back to the times of forced loans in the late Middle Ages. In this period, outsiders needed specific privileges in order to buy annuities, a restriction that aimed at preventing collective reprisals in cases of default (Sieveking 1905, p. 29; Molho 1995, pp. 107-08; Pezzolo 2005, pp. 156-57). In other words, we suggest that because medieval Italian urban governments valued fiscal autonomy (i.e. the right to transform a loan into a tax at will) above access to foreign capital, collective liability (where all merchants from a town were held responsible for the behaviour of each individual) hindered rather than helped the development of inter-city financial links. When securities sold on the primary market replaced forced loans in about 1500, governments relaxed their restrictions. They now often explicitly invited investors from abroad, and interest rate differentials shrank (see Figure 3).²⁶ Nevertheless, any gains were short-lived. Foreign investment remained more costly than local. 'Outsiders' were still discriminated against with partial defaults, taxation and liquidations (Pugliese 1924, pp. 339-76; Felloni 1971, pp. 146-47, 214-17, 289, 304-06, 315-17; Calabria 1991, pp. 128-29).

The difference to the regions north of the Alps is stark. There, investors acted in an environment shaped by what was probably the most complex political system of premodern Europe: the Holy Roman Empire, a multi-layered organisation whose influence varied over time and between regions. Expecting to find a catch-all institution that can explain the observed patterns on its own would therefore be misguided; rather, several mechanisms seem to have played a role.

Peter Moraw (1989, pp. 155-57, 416-18) has coined the term 'open constitution' to characterise the Empire's pre-sixteenth-century structure, which relied on few formal institutions and allowed many towns to develop their own legal systems. If they were not

granted the law of an already existing town when they were founded, they often modelled their law codes on that of a neighbouring town. The laws of Aachen, Frankfurt, Nuremberg, Vienna, Brunswick, Magdeburg and Lübeck played important roles in this context. In effect, ‘urban law families’ emerged (Kroeschell 2003, p. 25), making legal fragmentation far less pronounced than a look at the political map of the late medieval Empire would suggest. Moreover, unlike in Italy the widespread use of collective liability in the late Middle Ages may here actually have helped co-ordinating inter-urban exchange (Fryde and Fryde 1963, pp. 528-29, 533; Zijderduijn 2009, ch. 3; Boerner and Ritschl 2002, *passim*). Indeed, Edmund Fryde and Matthew Fryde (1963, pp. 528, 533) argue that as a result of collective liability foreign investment in the Empire was less risky than domestic investment.

Legal congruence and collective liability functioned within a political system characterised by the co-operation of groups of towns. Urban leagues formed, for example, to negotiate commercial treaties with rulers – this applies to the Hansa (Dollinger 1981, pp. 41-43) – or to provide military security – such as the Rhenish League of 1257 (Distler 2006, pp. 180-81). Regardless of how co-operation was motivated, it reduced transaction costs – for example, by facilitating information flows - and so helped inter-urban investment. This reasoning agrees well with our finding that the markets characterised by the strongest inter-city capital flows, the Lower-Saxon cluster centred on Lübeck and Lüneburg, formed the core of the Hanseatic League.

From the late fifteenth century onwards, when the Empire was fundamentally reformed (Angermeier 1984), urban leagues began to decline and urban law was assimilated into the legal codes that princes published within the framework of the Empire’s legislation (Wüst 2003, pp. 17-19). The Empire itself, that is, its Diet and the Supreme Courts, consistently favoured the rights of creditors. The threat that a Free Imperial city which failed to service its debts might be put under forced administration by an Imperial Debit Commission provided

incentives for punctual repayment (Kleinehagenbrock 2011, p. 71, Westphal 2002, pp. 265-67). This implied a fall in monitoring costs. To the extent that such costs typically increased with distance (Stasavage 2011, *passim*), their reduction is expected to affect long-distance investment, in particular.

How this played out in the case of territorial towns (not represented at the Imperial Diet but at least nominally under the rule of a prince) is a question that research has so far failed to address. However, any prince would have jumped at the chance to restrict urban autonomy, and when a town's creditors accused it of failing to service its debts this gave him a perfect excuse to bring such towns under his authority (cf. Kern, 2000). In consequence, as long as territorial towns were able to sell their own securities, they faced strong incentives to pay their creditors reliably as otherwise they would risk losing their autonomy.

Within the Empire, competition between authorities appears to have encouraged governments to improve the quality of their institutions. The Imperial constitution channeled political rivalries into forms that ultimately proved economically beneficial: Rather than degenerating into the Macchiavellian type of violence that characterised relations between the Italian states, rivalries between members of the Empire generally played out as peaceful competition for scarce mobile resources such as capital (Volckart, 1999, *passim*; 2002, pp. 184-86; see also Mokyr, 2017, pp. 170-72).²⁷ For example, from the early fifteenth century onwards urban officials and private agents acted as intermediaries, attracting capital from abroad.²⁸ Sometimes cities even arranged the pay-out to be delivered at the place of residence of the buyer, apparently at no extra cost.²⁹ Moreover, some contracts stipulated that the annual interest payment or, in cases of redemption, the repayment of the principal should occur in a place convenient for both parties. Occasionally fairs such as those in Frankfurt and Leipzig, and specialised markets like Hildesheim, were used for this purpose.³⁰ By contrast, early modern Genoese capitalists investing in other Italian cities had to pay a fee to a private

agent to have the payments delivered to them at financial fairs or at the local public bank (Felloni 1971, pp. 96-97).

While the Thirty Years War marked a temporary break down of the Imperial constitution and was a cataclysm of unparalleled proportions, Sheilagh Ogilvie's (1992, pp. 437-39) negative assessment of the effects of the 'seventeenth-century crisis' needs to be qualified. Promoting peace between its members remained the Empire's core function, and its institutions, including those relevant for capital markets, proved resilient after the Peace of Westphalia (Press 1991, pp. 379-84). Thus, Imperial Debt Commissions that administered states in danger of default remained in place into the early years of the nineteenth century (Westphal 2002, pp. 370-71). In sum, within the Empire inter-urban investment was far better protected than in Italy, where rivalries between polities increased transactions costs.

Factors other than creditor rights protection and competition between political authorities likely played some role, too. After all, it was not just regions such as Upper Germany, where Imperial institutional reach was deep, that integrated rapidly with the rest of the Empire from initially low levels, but also the Netherlands, where Imperial institutions had never been strong and weakened further from the sixteenth century (Press 1986). The Habsburg Netherlands attained a special constitutional status in 1548 but remained part of the Empire. Maximilian I (1459-1519) established the first regular postal route between the Netherlands and Upper Germany in the 1490s (Behringer 2011, pp. 348-49), and Charles V (1500-58) chose Antwerp to remit American silver across Germany and to raise loans from the Fuggers of Augsburg (Braudel 1982, pp. 150-51). The links so established coincided with the use of newly negotiable bills of exchange (Munro 2003, pp. 553-55) and aided inter-urban communications with the rest of the Empire. While not directly concerning annuity markets, such connections made for easier information flows and, all else being equal, reduced risk and so helped long-distance investment in long-term urban debts. Hence, in this instance,

Imperial politics – if not Imperial institutions – likely fostered the development of inter-regional capital flows.

Conclusion

Our analysis draws on a new dataset that extends the quantitative evidence available up to now. The findings demonstrate that Central European annuity markets were better integrated in terms of interest rate dispersion than their Italian counterparts. Comparing both regions reveals that in the early modern period integration advanced in the long run only in the Empire. While there was progress in Italy in the sixteenth century, the gains made there were short-lived. Within the Empire, cities in close proximity were well integrated from the start; the advances in integration that took place from the sixteenth century onwards concerned primarily markets more than 200 kilometres apart. The size and depth of the market reached particularly high levels around Lübeck and Hamburg, and it was in the main initially poorly integrated clusters of cities in the Netherlands and Upper Germany that improved their integration with the rest of the Empire.

Italian merchants and financiers had an undisputed edge in financial techniques. Yet Italian annuity markets were far less well integrated with each other than those in the Empire. The hypothesis emerging from the analysis of the data is that this difference was primarily due to institutions. Foreign investors north of the Alps were throughout far better protected than in Italy as urban authorities in the Empire improved the quality of their institutions in order to attract foreign capital. The Imperial constitution, which excluded the fiefs in Italy, appears as a credible deep cause of this contrast. Our findings challenge the argument that transaction costs are necessarily lower within territorial states than between cities in different polities (cf. Epstein 2000, p. 159). Given a constitutional framework that fostered co-operation between polities and induced them to compete by improving their protection of

property rights, political fragmentation and constitutional decentralisation do not *per se* and by necessity have adverse effects on the development and integration of capital markets (cf. Epstein 2000, p. 167; Volckart 2002, pp. 213, 217; Stasavage 2011, pp.162-64.). Testing these hypotheses formally remains the task for future research.

Online Appendix A: Data Sources

For each market, the entry first gives a description of the data and period coverage, followed by printed and/or archival sources.

Aachen: 20 interest rates on life annuities yielding six yearly means (1385-1439)

Kraus, T.R. (ed.) 2004. *Die Aachener Stadtrechnungen des 15. Jahrhunderts*. Düsseldorf, pp. 42, 57, 93, 168.

Laurent (ed.) 1866. *Aachener Stadtrechnungen aus dem XIV. Jahrhundert nach den Stadtarchiv-Urkunden mit Einleitung, Registern und Glossar*. Aachen: P. Kaatzer, pp. 295, 369.

Amiens: two interest rates on heritable annuities yielding two yearly means (1316 and 1494) and 1 interest rate on a life annuity yielding 1 yearly mean (1388)

Espinas, G. 1902. *Les finances de la commune de Douai, des origines au XVe siècle*. Paris: Picard, pp. 321, 328.

Maugis, M. E. 1899. *Essai sur le Regime Financier de la Ville d'Amiens du a la fin du XVI siècle (1356-1588)*. In *Memoires de la Societe des Antiquaires de Picardie*, Quatrieme Serie, Tome III, pp. 133-656, here pp. 563, 566.

Amsterdam: 847 interest rates on heritable annuities yielding 36 yearly means (1515-1795) and 1095 interest rates on life annuities yielding 36 yearly means (1543-1651)

Daston, L. 1988. *Classical Probability in the Enlightenment*. Princeton: Princeton University Press, p. 121.

Fritschy, W. 2003a. Three centuries of urban and provincial public debt: Amsterdam and Holland. In Boone, M., Davids, K., and Janssens, P. (eds.) *Urban Public Debts: Urban Government and the Market for Annuities in Western Europe (14th-18th Centuries)*. Turnhout: Brepols Publishers, pp. 75-92, here pp. 79, 83.

Tracy, J. D. 1985. *A Financial Revolution in the Habsburg Netherlands: Renten and Renteniers in the County of Holland, 1515-1565*. Berkeley, Los Angeles and London: University of California Press, pp. 45, 60, 133.

Van der Burg, M. and Hart, M. 2003. Renteniers and the recovery of Amsterdam's credit (1578-1605). In Boone, M., Davids, K., and Janssens, P. (eds.) *Urban Public Debts: Urban Government and the Market for Annuities in Western Europe (14th-18th Centuries)*. Turnhout: Brepols Publishers, pp. 197-218, here pp. 200, 204.

Stadsarchief Amsterdam [Amsterdam City Archives]:

No. 5014: Stadsrekeningen. Vol. 12, fol. 38v; Vol. 19, fol. 32r; Vol. 21, fol. 38v; Vol. 22, fol. 40v; Vol. 27, fol. 42v-43r; Vol. 33, fol. 54v; Vol. 34, fol. 52r; Vol. 36, fol. 55v-56r; Vol. 39, fol. 88r-89v; Vol. 40, fol. 55v-57v; Vol. 41, fol. 55v-57v; Vol. 42, fol. 62v-63v; Vol. 43, fol. 64v-66v; Vol. 44, fol. 61r-62v; Vol. 46, fol. 89r-90v; Vol. 47, fol. 60r-61v; Vol. 48, fol. 59r-61v; Vol. 50, fol. 70r-73r; Vol. 51, fol. 71r-74r; Vol. 52, fol. 72v-74r; Vol. 53, fol. 75v-77v; Vol. 54, fol. 68r-69v; Vol. 56, fol. 45v-46r; Vol. 59, fol. 35v; Vol. 61, fol. 35r-36v; Vol. 62, fol. 35v-37r; Vol. 63, fol. 32v-33r; Vol. 65, fol. 29v; Vol. 68; Vol. 69; Vol. 71.

No. 5025: Vroedschapsresoluties. Vol. 1: 16.1.1536-7.5.1565, fol. 113v, 123v; Vol. 2: 28.5.1565-11.1.1575, fol. 33r, 56v; Vol. 3: 16.1.1575-23.5.1578, fol. 19r-v; Vol. 6: 6.5.1588-1.5.1592, pp. 265, 436-7; Vol. 8: 14.5.1594-7.10.1603, pp. 13-14, 21-23, 25-26, 106-7, 858; Vol. 9: 13.10.1603-5.7.1610, p. 285; Vol. 10: 12.7.1610-28.1.1617, p. 224, 338-40; Vol. 19: 1649 januari 12-1652 augustus 29, fol. 158v.

No. 5044: Reeckeningen van overgeleverde losrenten, lijfrenten op eene lijve ende lijfrentenop twee lijven bij de stadt Amstelredamme verkocht. Vol. 461: Ingediend bij het kantoor der Staten van Holland, 1588 maart 10, fol. 2r, 3r, 12r; Vol. 462: Ingediend bij het kantoor der Staten van Holland, 1588 aug.3, nr. 4, fol. 2r, 3r, 31r; Vol. 463: Ingediend bij het kantoor der Staten van Holland, 1599 feb.17, nr. 7, fol. 1r, 2r, 5v, 9v, 11r, 12r.

No. 5044: Register van vercooping van Renten. Vol. 464: 1588 5e register gemerkt G, fol. 1r-24v; Vol. 465: 1589 5e register gemerkt F, fol. 1r-10v; Vol. 466: 1590 6e register gemerkt H, fol. 1r-10v; Vol. 467: 1591 6e register gemerkt I, fol. 2r-3r; Vol. 468: -1598, fol. 1r-12v; Vol. 469: 1603 6e register gemerkt M, fol. 1r-3r.

Antwerp: 305 interest rates on heritable annuities yielding 32 yearly means (1472-1775) and 146 interest rates on life annuities yielding 17 yearly means (1639-1778)

Stadsarchief Antwerpen [Antwerpen City Archives]:

[Registratie van erf- en lijrenten Reductiekas, renten op de Aluinen (1640-1642).] R280: 1640-1642, rentmeester Jan van Weerden.

[Registratie van erf- en lijrenten Reductiekas, renten op de Corpus (1748-1750).] R364: 1748-1750, erfrenten.

[Jaarlijkse rekeningen van de Reductiekas (1582).] R500: 1e rekening, alle cijzen en erfrenten.

[Erf-en lijfrenten van de consumptiekas (1646-1793).] R1513: 1646-1648, erf- en lijfrenten, rentmeester Jan Janssens; R1516: 1655-1657, erf- en lijfrenten, rentmeester Thomas de Potter; R1525: 1670-1672, erfrenten, rentmeester Jan Bruyninx; R1526: 1670-1672, lijfrenten, rentmeester Jan Bruyninx; R1527: 1673-1675, lijfrenten, rentmeester Jan Baptist Huart; R1528: 1676-1678, erfrenten, rentmeester Jan Baptist Poesson; R1533: 1685-1687, erfrenten, rentmeester Norbertus van Mockenborch; R1544: 1703-1705, erfrenten, rentmeester Jan van Miert; R1553: 1718-1720, erfrenten, rentmeester Ignatius Clouwet; R1581: 1775-1777, erf- en lijfrenten, rentmeester Jan Baptist de Wolf; R1582: 1778-1780, erf- en lijfrenten, rentmeester Jacques Jos de Moor.

[Erf- en lijfrenten op de lepel.] R1586: 1678-1681.

Arras: One interest rate on an heritable annuity yielding one yearly mean (1392) and six interest rates on life annuities yielding five yearly means (1241-1300)

Bougard, P. 1988. L'apogee de la ville (1191-1340). In Bougard, P., Hilaire, Y. and Nolibos, A. (eds.) *Histoire d'Arras*. France: Editions des Beffrois, pp. 53-76, here pp. 63-4.

Munro, J. H. 2003. *The Medieval origin of the financial revolution: Usury, rentes, and negotiability*. In *International History Review*, 25:3, 505-62, here p. 525.

Munro, J. H. 2007. *The Usury Doctrine and Urban Public Finances in Late-Medieval Flanders (1220-1550): Rentes, Excise Taxes, and Income Transfers from the Poor to the Rich*. Paper to be presented to the Washington Area Economic History Seminar at the University of Maryland Baltimore County on Friday, 11 May 2007, p. 10.

Richard, J. 1880. *Une conversion de rentes à Arras en 1392*. In *Bibliothèque de l'école des chartes*, tome 41, pp. 518-536, here p. 523.

Assen: 53 interest rate on a heritable annuities yielding 53 yearly mean (1640-1781) and 63 interest rates on life annuities yielding 63 yearly means (1700-1795)

van der Ent, L. and Fritschy, W. 1998. *Gewestelijke financiën ten tijde van de Republiek der Verenigde Nederlanden. Deel 2: Drenthe (1602-1795)*. Rijks Geschiedskundige Publicatiën uitgegeven door het Instituut voor Nederlandse Geschiedenis. Kleine Serie, Vol. 91. Den Haag: Instituut voor Nederlandse Geschiedenis. Table III.5.20, p. 210.

Assisi: Five interest rates on heritable annuities yielding five yearly means (1598-1689)

Girelli, A. M. 1992. *La Finanza Comunale nello Stato Pontificio del Seicento. Il Caso di Assisi*. Padova: Cedam, pp. 65, 69-70, appendix.

Augsburg: 85 interest rates on heritable annuities yielding 24 yearly means (1433-1501) and 6 interest rates on life annuities yielding 4 yearly means (1391-1447)

Espinas, G. 1902. *Les finances de la commune de Douai, des origines au XVe siècle*. Paris: Picard, p. 328.

Stadtarchiv Augsburg [Augsburg City Archives]:

S169 (1400-1437): Baumeisterbuch 14, 37; S170 (1437-1461): Baumeisterbuch 44-47, 50; S171 (1463-1477): Baumeisterbuch 60, 65-66, 70; S172 (1477-1491): Baumeisterbuch 73, 82; S173 (1491-1501): Baumeisterbuch 87; S174 (1501-1515): Baumeisterbuch 98.

Bar-sur-Aube: One interest rate on a life annuity yielding one yearly mean (1240)

Desportes, P. 1979. *Reims et les Rémois au XIIIe et XIVe siècles*. Paris: Éditions A. & J. Picard, p. 129.

Basel: 1135 interest rates on heritable annuities yielding 159 yearly means (1383-1601) and 685 interest rates on life annuities yielding 165 yearly means (1384-1601)

Harms, B. (ed.) 1909. *Der Stadthaushalt Basels im Ausgehenden Mittelalter. Quellen und Studien zur Basler Finanzgeschichte. Abt. 1: Die Jahresrechnungen 1360-1535. Vol. 1. Die Einnahmen.* Tübingen: Laupp, *passim*.

Staatsarchiv Basel-Stadt [Basel State Archives]:

AHA Missiven A 1: Missiven, Konzepte 1409 Oktober 12 - 1413 Dezember 18, pag. 82, 85; AHA Ratsbücher D 1: Abscheidebuch (1526-1542), fol. 135; D 2. Abscheidebuch (1541-1556), fol. 25v; AHA Städtische Urkunden (1180-1798): Nos. 1280, 2502, 2503, 2505, 2947, 2950, 2952, 3000, 3021; AHA Städtische Urkunden (Regesten) (0423-18. Jh.): Urkundenbuch VIII. fol. 95; Umschlag des Öffnungsbuches IV; Umschlag von E 45, no. 1; AHA Finanz H: Jahresrechnungen der Stadt Basel von 1444-1611, Fronfastenrechnungen von 1444-1700. Vols. 1535/36-1601/02.

Bergamo: One interest rate on an heritable annuity yielding one yearly mean (1622)

Pulin, F. 1985. *Il Monte di Pietà di Bassano (1492-1797)*. Vicenza: Edizioni L.I.E., p. 122.

Berlin: 11 interest rates on heritable annuities yielding seven yearly means (1588-1698)

Landesarchiv Berlin [State Archives Berlin]:

Rat zu Berlin. A Rep. 500 Berlinische Kämmereirechnungen: 1693-1694, alte Signatur R IV/3; 1697-1698, alte Signatur R IV/4); Rat zu Berlin. A Rep. 510 Coellnische Kämmereirechnungen: 1589-1590, alte Signatur R I/1; 1596-1597, alte Signatur R I/2; 1598-1599, alte Signatur R I/3.

Bologna: 92 interest rates on heritable annuities yielding 65 yearly means (1501-1754)

Carboni, M. 1995. *Il Debito della Città. Mercato del Credito, Fisco e Società a Bologna fra Cinque e Seicento*. Bologna: Il Mulino, p. 86.

Felloni, G. 1971. *Gli Investimenti Finanziari Genovesi in Europa tra il Seicento e la Restaurazione*. Milano: Dott. A. Giuffrè Editore, pp. 181-182.

Nanni, F. 1968. Erektionen de' Monti della città di Bologna e loro capitali e rendite. In Orlandelli, G. (ed.) *Due Relazioni sulla Erektion dei Monti di Pubbliche Prestanze in Bologna (1655-1744)*. Milan: Antonio Giuffrè, pp. 1-22, here pp. 6-21.

Pradelli, G. 1968. Relazione delle erektionen de Monti o siano luoghi de Monti di Bologna (1744-1762). In Orlandelli, G. (ed.) *Due Relazioni sulla Erektion dei Monti di Pubbliche Prestanze in Bologna (1655-1744)*. Milan: Antonio Giuffrè, pp. 23-117, here pp. 39, 51, 58-9, 61, 63, 65-7, 70-2, 76, 85-87, 89, 92-3, 95-7, 99, 104-6, 108-11, 113.

Vietti, A. 1884. *Il Debito Pubblico nelle Provincie che hanno formato il Primo Regno d'Italia Secondo i Documenti del R. Archivio di Stato Lombardo*. Milano: Emilio Quadrio Editore, p. 137.

Bonn: 26 interest rates on heritable annuities yielding 20 yearly means (1550-1780)

Stadtarchiv Bonn [Bonn City Archives]:

Ku 80/3 Schuldurkunden, Städtische Schulden. Teil 1: 1550 - 1780; Teil 2: 1550 – 1783;
Ku 80/4 Maaß'sches Kapital, 1578-1777 (Städtische Schulden); Ku 80/9 Schuldbrief der Stadt Bonn vom 1. Juni 1761 und darauf sich beziehende Dokumente, 1761 (Städtische Schulden).

Bremen: 1409 interest rates on heritable annuities yielding 233 yearly means (1357-1802)

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Stadsarchief Brugge [Bruges City Archives]:

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Brunswick: Three interest rates on heritable annuities yielding three yearly means (1396-1416) and 758 interest rates on life annuities yielding 190 yearly means (1392-1664)

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CC 12: 1-12 Registres de cens; CC 13: Registres aux capiteaux engages par Colmar et revenus patrimoniaux; CC 14: Echange de titres avec Zorn von Bulach; CC 15: Capiteaux et cens dus par le gouvernement autrichien a Colmar; CC 16: Obligations, engagements, decompes; CC 17: Reclamations de la ville a differents bourgeois, quittances, decompes, lettres de cens, correspondance (1402-1741); CC 18: Listes des cens payes; CC 27: Decomptes, echanges, actes d'achat, heritages, partages (1654-1699); CC 30: Decomptes (1678-1700); CC 31-32: Liquidation de dettes; CC 35: Lettres de cens, releves de fortune, fondations pour de tierces personnes (1393-1693); CC 38: Nombreaux actes.

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Stadtarchiv Freiburg [Freiburg City Archives]:

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Stadsarchief Gent [Ghent City Archives]:

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Hanover: 1097 interest rates on heritable annuities yielding 303 yearly means (1315-1723) and 383 interest rates on life annuities yielding 141 yearly means (1350-1606)

Stadtarchiv Hannover [Hanover City Archives]:

Urkunden-Abteilung 1: Allgemeine Urkundensammlung (14.-18. Jh.). Nos. 184, 207, 463, 465, 481, 525, 537, 542, 553, 559-60, 565, 570, 587, 599, 614, 618-9, 622-3, 668-9, 685, 689, 701, 707, 737, 741, 745, 753, 835, 846-7, 935, 942, 989, 1103, 1161, 1207, 1268, 1272-3, 1355, 1373, 1461, 1598, 1774, 1806, 1811, 1815, 1828; Urkunden Abteilung 3: Schuldurkunden des Rates (1351-1716). Nos. 1, 9, 12, 14, 18, 25-6, 39, 41-7, 50-2, 54-7, 59-60, 62, 64, 73, 76-7, 83, 86-90, 96, 93-101, 103-8, 111-3, 115-20, 122-4, 128, 130, 132-4, 136-9, 141-8, 150-64, 166, 168-73, 175-6, 178-83, 185-6, 189, 191-6, 198-206, 208-18, 220-36, 238-41, 248, 251-4, 257-66, 268-78, 280-9, 291-301, 304-38, 340-3, 345-51, 354-64, 366-412, 414-25, 428-42, 444-70, 473-5, 477-9, 482-3, 486-8, 490-1, 493-6, 498-503, 505-29, 531-2, 536-58, 561-646, 648-60, 662-3, 667, 669, 671-90, 692-3, 695, 698-718, 720-57, 759, 761-87, 789-93, 798-822; Neue Abteilung Bücher 7227-7230: Kämmereibücher. No. 7227, pp. 110-1, 187, 195-6, 232-3, 312-3, 349, 386, 387, 442-3, 486, 524-5, 564, 566, 606, 646, 732-3, 766, 802, 836, 876, 912, 956, 998, 1116; no. 7228, pp. 2, 38-9, 78, 165-6, 278, 308, 340-1, 396-7, 430, 434-5, 471, 514, 603, 646, 688, 737, 1233; no. 7229, pp. 2, 27, 381, 383; no. 7230, fol. 30r-v; Neue Abteilung Bücher, 8242 Stadtobligationsbuch 1387-1533, *passim*; Neue Abteilung Bücher, 8043 Stadtobligationsbuch I, *passim*; Neue Abteilung Bücher, 8044 Stadtobligationsbuch II, *passim*; Neue Abteilung Bücher, 8060 Schuldbuch betreffend die angeliehenen Kapitalien, fol. 4r-v, 5v, 6r, 8r-v.

Hildesheim: 59 interest rates on heritable annuities yielding 72 yearly means (1333-1600) and 246 interest rates on life annuities yielding 54 yearly means (1328-1564)

Stadtarchiv Hildesheim [Hildesheim City Archives]:

Bestand 1 Nr. 1275: Schuldverschreibungen. Nos. 1275a-zzzz; Bestand 50 Nr. 159: Kämmereirechnungen. Vols. 1417, fol. 2r; 1419, fol. 1v; 1420, fol. 1v; 1421, fol. 1v; 1422, fol. 1v; 1425, fol. 1v; 1427, fol. 1v; 1428, fol. 1v; 1429, fol. 1v; 1437, fol. 1v; 1440, fol. 1v; 1441, fol. 1v; 1442, fol. 130v-131r; 1443, fol. 208v-209r; 1444, fol. 308r; 1445, fol. 2r; 1446, fol. 2r; 1447, fol. 2r; 1448, fol. 2r; 1449, fol. 2r; 1451, fol. 2r; 1452, fol. 2r; 1453, fol. 2r; 1454, fol. 2r; 1455, fol. 2r; 1456, fol. 2r; 1457, fol. 2r; 1458, fol. 2r; 1459, fol. 2r; 1461, fol. 2r; 1462, fol. 2r; 1464, fol. 2r; 1465, fol. 2r; 1469, fol. 2r; 1490, fol. 2r; 1491, fol. 2r; 1492, fol. 2r; 1494, fol. 2r; 1496, fol. 2r-v; 1497, fol. 2r-v; 1498, fol. 2r-v; 1499, fol. 2r-v; 1500, fol. 2r-v; 1501, fol. 2r-v; 1502, fol. 2v; 1503, fol. 2v; 1506, fol. 2r; 1508, fol. 2r; 1509, fol. 2r; 1510, fol. 2r-v; 1511, fol. 4r-v; 1512, fol. 81r, 82r-v; 1514, fol. 2r-v; 1519, fol. 90r-92r; 1520, fol. 4r-5r; 1521, fol. 80r-v; 1522, fol. 159r-v; 1523, fol. 2r-3r, 4r; 1524, fol. 80r-81v; 1525, fol. 149r-150r; 1526, fol. 2v-3v; 1527, fol. 67r-v; 1528, fol. 134r-v.

Hoorn: One interest rate on an heritable annuity yielding one yearly mean (1522)

Tracy, J. D. 1985. *A Financial Revolution in the Habsburg Netherlands: Renten and Renteniers in the County of Holland, 1515-1565*. Berkeley, Los Angeles and London: University of California Press, p. 45.

Huy: 11 interest rates on heritable annuities yielding 10 yearly means (1649-1675)

Morsa, D. 2003. La dette de la ville de Huy au 17e siècle. In Boone, M., Davids, K., and Janssens, P. (eds.) *Urban Public Debts: Urban Government and the Market for Annuities*

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Koblenz: 52 interest rates on heritable annuities yielding 26 yearly means (1610-1797)

Stadtarchiv Koblenz [Koblenz Town Archives]:

Bestand 623 Stadt Koblenz: No. 2884 Städtische Schulden (1611-1791), vols/fol. 1, 3, 7, 11, 16, 18, 28, 31, 38, 42, 45, 49, 53, 55, 62, 65, 67; no. 2893 Die Stadtschulden (1794-1811), vol/fol/pp. 15, 18.

Leeuwarden: 146 interest rates on heritable annuities yielding 49 yearly means (1693-1770) and 54 interest rates on life annuities yielding 28 yearly means (1617-1758)

Trompetter, C. 2007. *Gewestelijke financiën ten tijde van de Republiek der Verenigde Nederlanden. Deel 6: Friesland (1587-1795)*. Rijks Geschiedskundige Publicatiën uitgegeven door het Instituut voor Nederlandse Geschiedenis. Kleine Serie, Vol. 106. Den Haag: Instituut voor Nederlandse Geschiedenis. Table III.5.44, pp. 185-91.

Leiden: 425 interest rates on heritable annuities yielding 31 yearly means (1439-1530) and 66 interest rates on life annuities yielding 16 yearly means (1361-1530)

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Regionaal Archief Leiden [Leiden Provincial Archives]:

SA I (1290-1575): Inv.nrs. 817, 838, 841: Rentebriefe, 1485, 1514, 1527; Inv.nrs. 818-835: Register van lijf- en losrenten ten laste van de stad, 1473-1552. Inv.nr. 818, fol. 3v, 8v, 17v; inv.nr. 819, 1r, 2v, 4v-8v, 16r, 17v, 18r, 21r-22r, 24r-25r, 28r, 29r-v, 31v, 33v,

37r-v, 42r-v, 43r, 44r-45r, 46v, 47r-v, 48r-v, 49v, 54r, 55r, 57v, 58r, 59v-60r, 61r, 62v-63v, 68r, 69r, 70v-71r, 73r-v, 76v-77r, 78r, 79v, 80v, 81v, 83r, 83v, 84v, 87r, 88r, 89r-90r, 91r, 92r-93v, 94v, 95r, 98r-v, 100r, 101v, 102v, 103v, 104r-105r, 106r, 107v, 109r-v, 110r-v, 111v, 114v, 117v, 125r, 131r-v, 132r-v, 133v, 134r, 136r-v, 137r-v, 138r, 139r-140v, 141v, 142r-v; inv.nr. 820, fol. 12r, 14r, 18r-v, 20r, 22r, 23r, 24v-25v, 27r-v, 28v; inv.nr. 825, fol. 2r-3r, 4v, 8r, 9r-v, 11v, 14r-v, 15v-16r, 17r, 18r-v, 19v, 20r, 27v, 28v, 30r-32r, 33r-v, 34r, 37r-v, 38r-v, 40r-42v, 47r-48r, 49v-50r, 51r-52r, 53r, 54r, 55v, 59v, 61r-64r, 65r-v, 66v-67v, 68v, 69r, 70r, 71r-72r, 74v-75r, 76r-v, 77v-78r, 79r-81r, 82r-83r, 84v-85r, 86r-89v, 90r, 92r-93r, 94r-95r, 96r, 97r-v, 99r, 100v-103r, 107v, 112r, 114r, 122r-v, 124r, 125v, 126r, 127v-130r, 131v, 132v, 133r-v; inv.nr. 833a, fol. 43v, 51r-53r, 54v, 55v-56r, 60v-61v, 62v, 63v-64v, 65v-67v, 77r, 78r, 79v, 83r; Inv.nr. 843: Register van de ontvangst uit verkochte lijf- en losrenten, 1528, fol. 5r-6r; Inv.nr. 852: Kwitanties van de koopsom van door de stad verkochte lijfrentebrieven, 1555-1568, nrs. 1-24; Inv.nr. 853: Register van lijfrenten verkocht van 1556 tot 1559. 1556-1559, fol. 1v, 2v-8r; Inv.nr. 856: Stukken betreffende de aankoop van een lijfrente van 24 gulden ten laste van de stad Leiden, voor elk van zijn kinderen gekocht door jonkheer Jacob van der Does, 1565; SA II (1574-1816): Inv.nr. 10161: Los- en lijfrentebrieven ten laste van de stad, uitgegeven in 1600, 1604, 1672, 1674, 1681, 1684, 1780, 1789. Met enkele bijlagen, 1614, 1654, 1796. 1600-1796.

Leipzig: 181 interest rates on heritable annuities yielding 14 yearly means (1475-1625)

Stadtarchiv Leipzig [Leipzig City Archives]:

JHR 1473-75 (Bd. 2), fol.00175; Titel V 17: Acta des Ratheszu Leipzig Schuld-Wesen betretig de Anno 1625-1642, fol. 168-9, 171-5, 177, 180, 208, 210-1; Title VI 1a: Depostenbuch, fol. 22r; Verzeichnunge der verpferding Jar 1517 (v.2).

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AG 40; Reg. 2526; Reg. 2527, fol. 2-5, 7-9, 11, 14, 17, 20, 22, 33-4, 37, 40, 42, 52, 56, 63, 66-7, 73, 93, 98, 116, 118-20, 122, 133, 136, 166-7, 169-72, 176-7, 183-5, 190-3, 195, 198, 200-1, 206-8, 210-2, 215-20, 223-4, 232; Reg. 2528, fol. 1-9, 12-3, 15, 17-8, 20, 26-8, 34-8, 40-2, 44, 47-9, 51-3, 55-6, 58-9, 61-4, 66-8, 70, 72-6, 78-80, 82, 87, 90-2, 94, 96-7, 100-3, 105-7, 109-11, 113, 115, 119-22, 125, 128-34, 137-40, 142, 144-5, 147-8, 150, 153-4, 157, 159, 161-4, 167-9, 172-3, 175, 177, 179-80, 182-3, 185-6, 189, 191,

194-201, 203-4, 227-9, 231, 233-9, 241-2, 244-5, 247-8, 250-2, 255, 257-8, 262, 273, 275-6; Reg. 2529; Reg. 2530; Reg. 2531; Reg. 2898, fol. 14, 17, 29, 41; Reg. 2899; Reg. 2900, fol. 9-10; Reg. 2946; Reg. 16012, fol. 11-12; Reg. 16014, fol. 10-1; Reg. 16030, fol. 9; Reg. 16031, fol. 9; Reg. 16032, fol. 9; Reg. 16033, fol. 9; Reg. 16035, fol. 8; Reg. 16036, fol. 9; Reg. 16037, fol. 7-8; Reg. 16039, fol. 7; Reg. 16040, fol. 7; Reg. 16042, fol. 7; Reg. 16043, fol. 6-7; Reg. 16045, fol. 8; Reg. 16046, fol. 8; Reg. 16048, fol. 9; Reg. 16050, fol. 8; Reg. 16051, fol. 8; Reg. 16052, fol. 9; Reg. 16053, fol. 9; Reg. 16054, fol. 8; Reg. 16055, fol. 8-9; Reg. 16063, fol. 6; Reg. 16067, fol. 7; Reg. 16069, fol. 7; Reg. 16070, fol. 7-8; Reg. 16071, fol. 7; Reg. 16072, fol. 7; Reg. 16073, fol. 6; Reg. 16074, fol. 6; Reg. 16075, fol. 6; Reg. 16076, fol. 7-8; Reg. 16077, fol. 7; Reg. 16078, fol. 7; Reg. 16080, fol. 6; Reg. 16084, fol. 7; Reg. 16085, fol. 6; Reg. 16088, fol. 5-6; Reg. 16092, fol. 6; Reg. 16093, fol. 6-7; Reg. 16096, fol. 5; Reg. 16098, fol. 5; Reg. 16265, fol. 47; Reg. 16723; Reg. 16729; Reg. 16730; Reg. 16731; Reg. 16732; Reg. 16733; Reg. 16734; Reg. 16736; Reg. 16737; Reg. 16771; Reg. 16783; Reg. 16785, fol. 177, 181-2; Reg. 16786.

Lübeck: 464 interest rates on heritable annuities yielding 93 yearly means (1439-1530) and six interest rates on life annuities yielding five yearly means (1286-1526)

Archiv der Hansestadt Lübeck [Lübeck City Archives]:

03.04-01.44.1. Kämmerei, Rentebücher: Nos. 1916 (1516-1530), 1917 (1545-1582), 1918 (1582-1612), 1919 (1612-1661); 03.04-02.9.3. Stadt-Cassa: No. 1402, Jährliche Rentebücher Nr. 2 (1667-1669); no. 1403, Jährliche Rentebücher Nr. 3 (1670-1671); no. 1404, Jährliche Rentebücher Nr. 4 (1672-1673); no. 1405, Jährliche Rentebücher Nr. 5 (1674-1675); 1406, Jährliche Rentebücher Nr. 6 (1676-1677); no. 1413, Jährliche Rentebücher Nr. 13 (1689-1690); no. 1423, Jährliche Rentebücher Nr. 23 (1708-1709); no. 1433, Jährliche Rentebücher Nr. 33 (1719); no. 1437, Jährliche Rentebücher Nr. 37

(1723); no. 1447, Jährliche Rentebücher Nr. 47 (1733); no. 1457, Jährliche Rentebücher Nr. 57 (1743); no. 1464, Jährliche Rentebücher Nr. 64 (1750); 08.01-5.1.02. Wissenschaftliche Handschriften, Brandt, Ahasver von: No. 1054, Auszüge der Renteneinträge aus dem Oberstadtbuch 1320-1350 von A. v. Brandt; 08.01-5.2.1. Bearbeitung der Urkunden und Testamente im AHL: No. 1046, Materialien u. Vorarbeiten zum Lübecker Urkundenbuch, besonders für Band VI-XI. Kämmereibücher: Mappe 2-4.

Lüneburg: 2014 interest rates on heritable annuities yielding 243 yearly means (1363-1718) and 66 interest rates on life annuities yielding 14 yearly means (1386-1563)

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Mainz: Nine interest rates on heritable annuities yielding 2 yearly means (1410-1436) and 25 interest rates on life annuities yielding 2 yearly means (1410-1436)

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Montanari, D. 2001. *Il Credito e la Carità. Volume I: Monti di Pietà delle Città Lombarde in Età Moderna*. Milano: Vita e Pensiero, pp. 50-1, 68-9, 78-9, 243.

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- Monferrato:** Two interest rates on heritable annuities yielding two yearly means (1730-1731)
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A 5135: Kopienbuch der von der Stadt Soest aufgenommenen Kapitalien (1499-1530), fol. 2r-3v, 4r, 5v, 6r, 7r-13v, 15r-v; A 5137: Kopiar der Leibrentenbriefe der Stadt Soest (1502-1524), fol. 2r-13r, 14r-16v, 17v; A 5141: Designation der Gelder, die im Jahre 1616 zu Behuf der Stadt aufgenommen wurden (1616), 2r; A 5142: Protokoll der von der Stadt Soest herausgegebenen Obligationen (1622-1635), pp. 3, 16-23, 25, 27, 29-32, 34-6, 38, 40, 42; A 5143: Verzeichnis der von der Stadt Soest aufgenommenen Geldsummen (1628), fol. 2v, 4r-v, 6r; A 5144: Abschriftliche Sammlung der von der Stadt Soest herausgegebenen Obligationen (1629-1719), fol. 1r-v, 5r-6r, 10r-11v, 46r-v, 86r-87r, 88r-89r, 116r-117r, 158r-159r, 176r-177r, 186r-187r, 196r-v, 199r-v, 202r-203r, 209r-210r, 214r-v, 216r-v; A 5145: Akten betr. Die Kapitalschulden der Stadt Soest (1636-1719), fol. 12r; A 5154: Aufstellungen über die Obligationen zu Lasten der Stadt Soest (1716), fol. 4v, 6r-8r, 10v-11r; A 5155: Kredittabelle sowie Kredit- und Zinsetat der Stadt Soest (1717), fol. 8v-9r, 10v-11r; A 5161-5383: Kredit- und Schuldenwesen, Specialia, nos. 5175, 5178, 5181, 5191, 5196-5203, 5207-9, 5212-5, 5217, 5219, 5220,

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Strasbourg: 893 interest rates on heritable annuities yielding 118 yearly means (1525-1791) and one interest rate on a life annuity yielding 1 yearly mean (1776)

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Online Appendix B: Clustering Technique

Model-based clustering with an ultrametric space is a technique to identify groups of nodes in a network (groups of cities and their hinterlands¹ in our case) that are linked by a tie (in our case capital flows) (Schweinberger and Snijders 2003). It assumes that observed links are the product of a stochastic process. It is particularly suited to our context since this method identifies clusters across various levels of network intensity and thus it makes it possible to fully exploit the information provided by capital flows.

The likelihood that we recorded all the links between cities in the sample increases with the number of observations on imports per city. This implies that it is desirable to include in the analysis only relatively well-covered cities, or else we are bound to miss a non-trivial number of existing links. Yet, the fewer cities are included, the smaller is the area covered by the analysis. With this trade-off in mind, we focus on the 28 cities for each of which we have at least 10 observations on investments made from other cities and their hinterlands.

For robustness, we re-run the analysis with the following two other samples: one with the 12 cities with at least 80 observations on imports and one with all the 210 places named in the

¹ A place is considered to belong to the hinterland of the closest other place that had at least 5000 inhabitants at some point in time during the period covered here (1228 to 1802). Using links between places instead worsens the results as the adjacency matrix becomes too sparse. In most cases, the distance between the hinterland-place and its 'central' town is small: less than 20 km in 85 per cent of the cases, and 70 km at most.

sources. As an example, Figure B.1 below shows the geographical origins of foreign investors for the sample of the 12 cities with the best data coverage. Although this sample is biased towards North Germany, it includes important centres from other areas and mitigates the negative bias on the connectivity implied by failure to record existing links. In addition, to investigate possible changes in the clusters over time, we also run the analysis including only observations from before 1520 and from 1520 onwards, for cities with at least 10 observations on imports.

< Figure B.1 about here >

Recorded capital flows between linked cities are bound to increase with their numbers of observations. This sample bias is econometrically addressed by regressing capital flows between city-pairs against the log of the sum of their numbers of observations on imports, using a negative-binomial specification. We use this technique because count regressions have desirable properties for estimating the determinants of bilateral flows (they do not suffer from the bias created by the logarithmic transformation and from the failure of the homoscedasticity assumption) and over-dispersion turns out to be a problem, thus cautioning against the use of a Poisson specification (Burger, Van Oort and Linders 2009). The capital flows that would have taken place if all linked cities were evenly covered are then estimated with the residuals. These are subsequently normalised to take values between 0 and 1. Hence, our measure of network intensity is capital flows compared to that of the pair with the highest value: This is Lübeck-Lüneburg, where we find that capital flows (18,799 consumption baskets) were 17,514 consumption baskets greater than expected on the basis of their combined coverage (698 observations).

The model assumes that links within a cluster are symmetric and that clusters are not overlapping at any given level of capital flows. These assumptions are bound to be violated to some extent. However, they are shared by other clustering procedures and imply that groups

are identified where the assumption of direct arbitrage between cities is closely approximated. Clusters can be identified either with a maximum likelihood or a Bayesian estimator. While the Bayesian estimator provides a more elegant model selection procedure, it yields in the present case unstable and occasionally implausible settings that suggest a poor fit with the data. We therefore use the maximum likelihood estimator. As our measure of strength is continuous, we assume a Gaussian distribution. To investigate possible non-convergence, we run ten sequences. Given that there are 28 cities in the main sample we allow up to seven different levels of clustering. The results are reported in Table B.1, where the second to the seventh columns report the expected network intensity at each clustering level for each total number of levels.

<Table B.1 about here>

The log-likelihood function is maximised when we assume seven different levels, but the difference is big only when compared to a total of two or three levels. Inspection of the output reveals that non-convergence may be an issue, as evidenced by unstable maxima of the log-likelihood function, when we assume that there were five levels or more. Moreover, the results are qualitatively very similar for four to six levels: All detect very close values at levels 1 to 3 and sharp drops in network intensity subsequently. Hence, no important information is lost by only considering four levels, and we therefore present this model in the paper. The only new result emerging from the robustness checks is that enlarging the sample reveals a wide cluster around Nuremberg, which developed strong links with Salzburg and Maribor.

Online Appendix C: Supplementary Figures

< Figure C.1 here >

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Table 1: Observations by source type and annuity type

Annuity Type		Heritable Annuity		Life Annuity		Total
Source Type	Empire	Italy (primary market)	Italy (forced loans)	Empire	Italy	
	1	3	4	5	6	7
Letters	9,179	0	0	1,422	0	10,601
Ledgers	6,344	518	0	717	2	7,581
Urban Accounts	5,001	0	0	2,820	0	7,821
Edicts	49	466	0	11	67	593
Secondary sources	724	1,393	349	288	26	2,780
Total	21,297	2,377	349	5,258	95	29,376

Sources: Online Appendix A.

Table 2: Long term trends in capital market integration

Sample	Asset	Years	Sample size	Initial spread	Final spread	Yearly rate of change*100	Cumulated change*100
		1	2	3	4	5	6
All	Heritable annuity	1315-1805	5004	1.253	1.169	-0.014***	-6.63
All	Life annuity	1320-1794	1412	1.142	1.081	-0.011***	-5.29
Empire	Heritable annuity	1344-1802	3428	1.170	1.100	-0.014***	-6.00
Empire	Heritable annuity	1493-1802	2637	1.137	1.104	-0.010***	-2.93
Empire	Life annuity	1320-1794	1330	1.144	1.065	-0.015***	-6.97
Italy	Heritable annuity	1362-1800	1439	1.329	1.255	-0.013***	-5.52
Italy	Heritable annuity (excl. forced loans)	1493-1800	1367	1.250	1.285	0.009*	2.79

*=Significant at 10 percent level; **=Significant at 5 percent level; ***=Significant at 1 percent level.

City fixed effects.

Sources: Online Appendix A.

Table 3: Inter-city investment in the Empire: trends in average distance (in km) and average capital invested (in consumption baskets)

Variable	Years	Sample Size	Yearly rate of change*100	Cumulated change*100	Initial value	Final value
	1	2	3	4	5	6
Distance	1228-1802	1434	0.159***	148	47	116
Capital	1328-1798	1320	0.222***	183	31	87

*=Significant at 10 percent level; **=Significant at 5 percent level; ***=Significant at 1 percent level. Importer city fixed effects.

Sources: Online Appendix A.

Table 4: Integration of capital markets in the Empire: the role of distance (in km)

Distance	Sample size	Years	Yearly rate of change*100	fitted pairwise differentials at start	fitted pairwise differentials at end	Cumulated change*100
	1	2	3	4	5	6
<200	6258	1333-1795	-0.023***	1.225	1.100	-10.181
>200	15183	1320-1804	-0.042***	1.360	1.109	-18.435

*=Significant at 10 percent level; **=Significant at 5 percent level; ***=Significant at 1 percent level. City-pair fixed effects.

Sources: Online Appendix A.

Table 5: Integration of capital markets in the Empire: within and between clusters

Within integration						
	sample size	Years	Yearly rate of change*100	Fitted differential at start	Fitted differential at end	Cumulated change*100
	1	2	3	4	5	6
Breisgau	241	1396-1741	-0.016*	1.093	1.035	-5.318
Lower Saxony	1591	1351-1750	-0.022***	1.152	1.056	-8.283
Upper Germany	210	1388-1551	0.023	1.092	1.133	3.764
Hessen	108	1550-1760	-0.004	1.038	1.028	-0.922
Upper Saxony	61	1497-1621	0.002	1.052	1.055	0.259
Westphalia	236	1350-1760	-0.002	1.078	1.068	-0.992
Northern Netherlands	364	1520-1795	0.002	1.082	1.087	0.499
Southern Netherlands	167	1392-1775	0.028***	1.027	1.143	11.218
Between integration						
	sample size	Years	Yearly rate of change*100	Fitted differential at start	Fitted differential at end	Cumulated change*100
Breisgau	447	1383-1791	-0.008	1.136	1.101	-3.081
Lower Saxony	1653	1320-1804	-0.004*	1.138	1.114	-2.112
Upper Germany	402	1382-1804	-0.037***	1.255	1.071	-14.611
Hessen	232	1410-1797	-0.009	1.116	1.077	-3.516
Upper Saxony	196	1320-1698	-0.011	1.119	1.073	-4.04
Westphalia	415	1350-1780	-0.001	1.108	1.106	-0.225
Northern Netherlands	501	1422-1795	-0.062***	1.389	1.100	-20.771
Southern Netherlands	346	1360-1795	-0.060***	1.381	1.063	-23.056

*=Significant at the 10 percent level; **=Significant at the 5 percent level; ***=Significant at the 1 percent level. City fixed effects.

Sources: Online Appendix A.

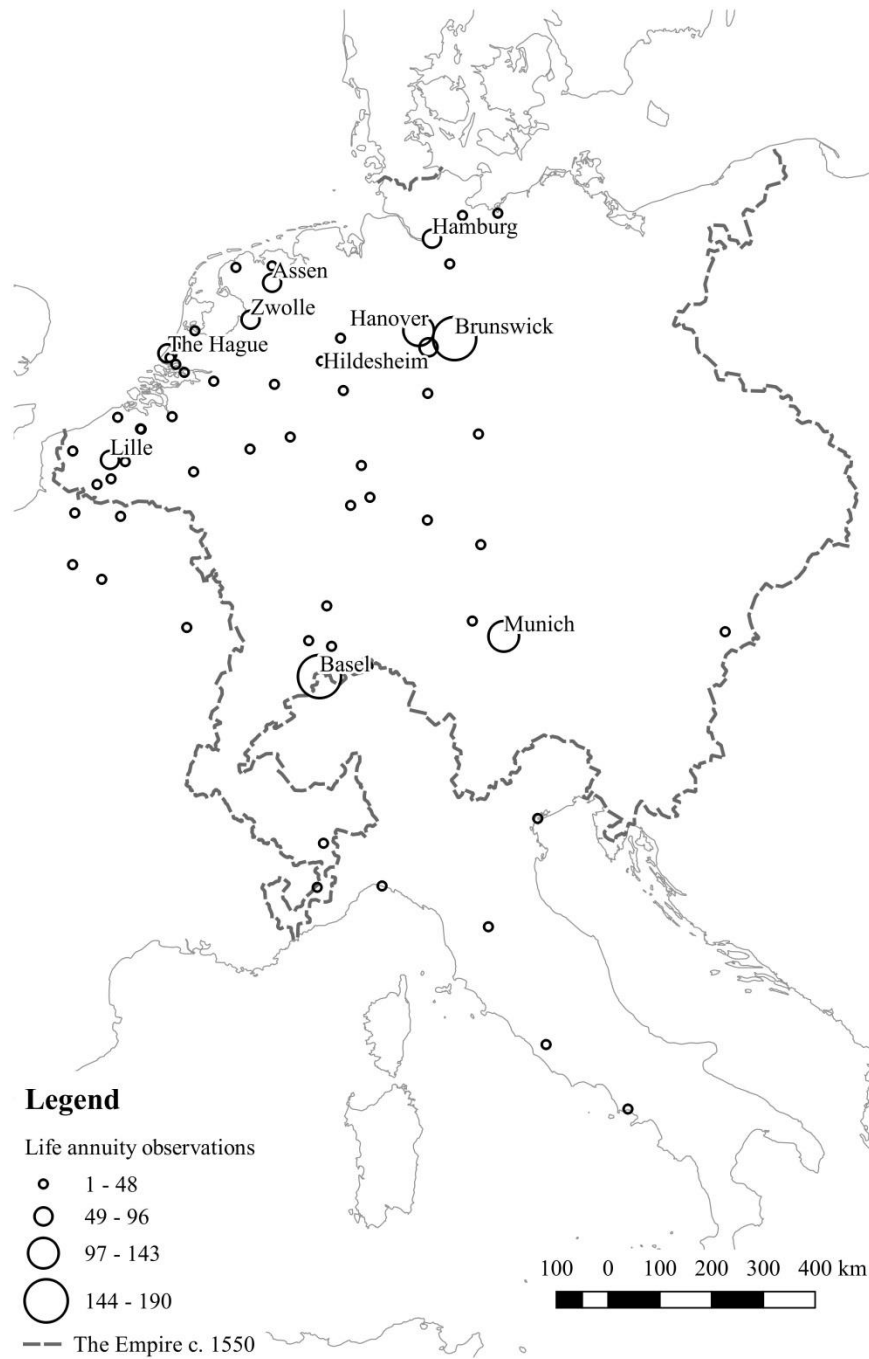
Table B.1: Network clustering: expected network intensity by level and number of levels

Level	7	6	5	4	3	2
N. of levels						
1	1.000	1.000	1.000	1.000	1.000	0.275
2	0.476	0.364	0.364	0.364	0.206	0.013
3	0.297	0.163	0.163	0.150	0.010	
4	0.148	0.025	0.039	0.009		
5	0.009	0.005	0.008			
6	0.009	0.000				
7	0.009					
Log likelihood	-0.491	-0.516	-0.520	-0.531	-0.734	-1.3191

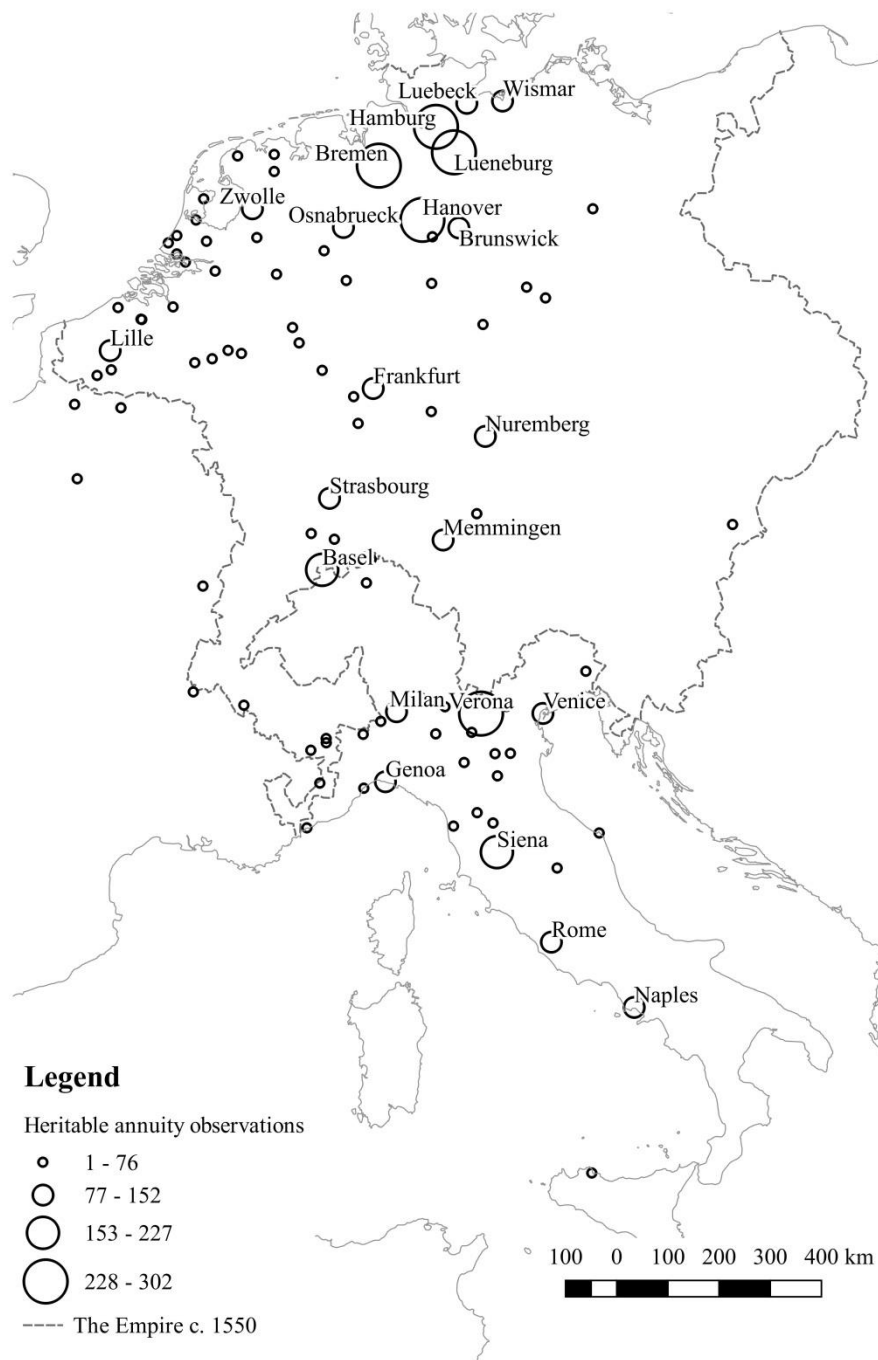
Sources: Online Appendix A.

Figure 1: Interest rate observations (yearly means), 1240-1809: geographical distribution

a) Life annuities

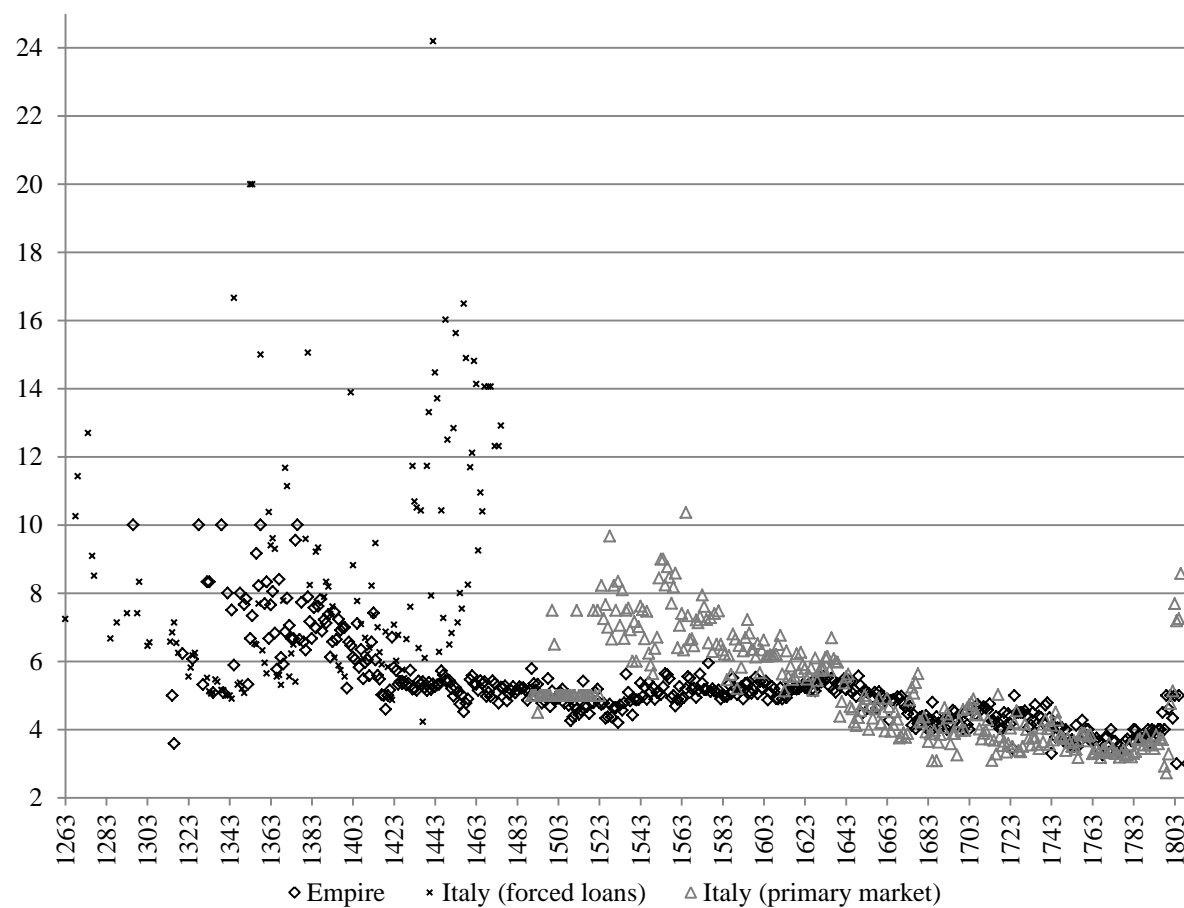


b) Heritable annuities



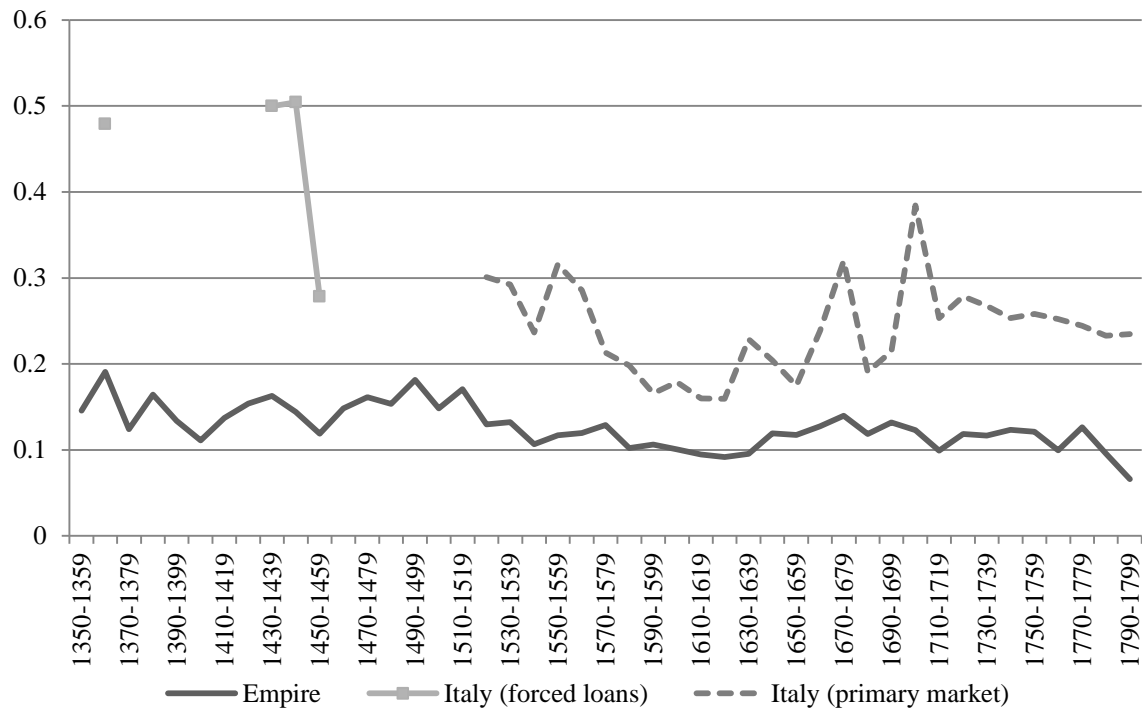
Sources: Online Appendix A.

Figure 2: Nominal interest rates on heritable annuities in the Holy Roman Empire and Italy, 1263-1809 (yearly means, in per cent)



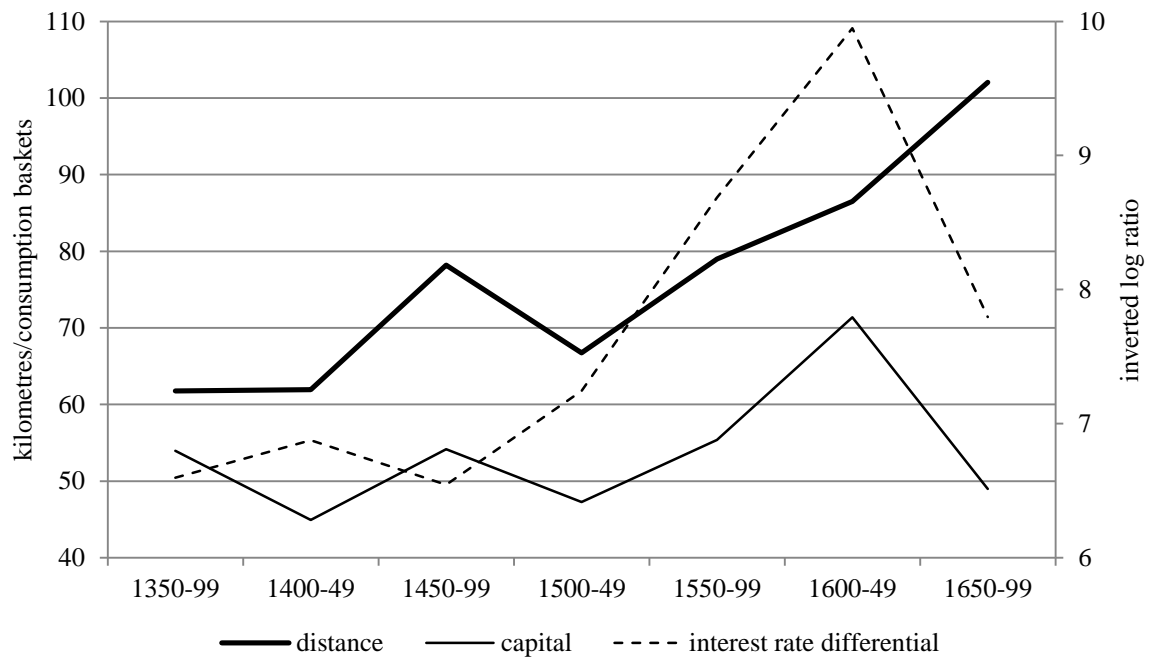
Sources: Online Appendix A.

Figure 3: Capital market integration in Italy and the Empire: panel trends (logs of differentials around the mean)



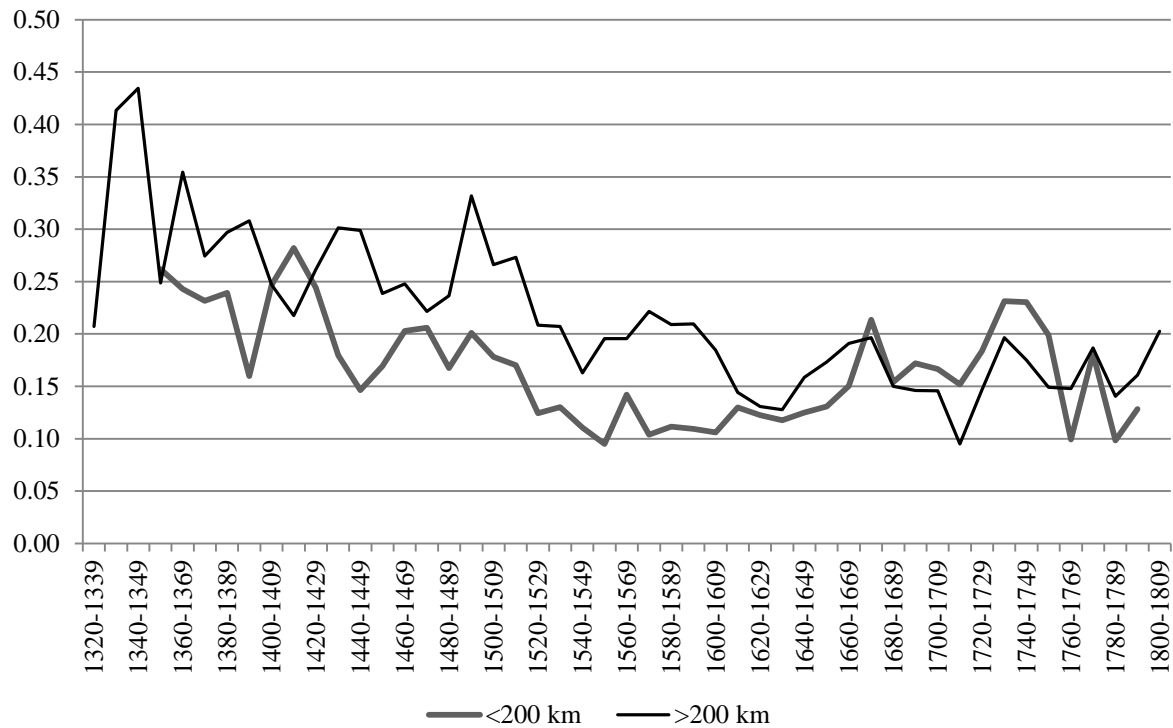
Sources: Online Appendix A.

Figure 4: Inter-city investment in the Empire: trends in distance (in kilometres) and capital (in consumption baskets) compared to interest differentials (inverted log ratio)



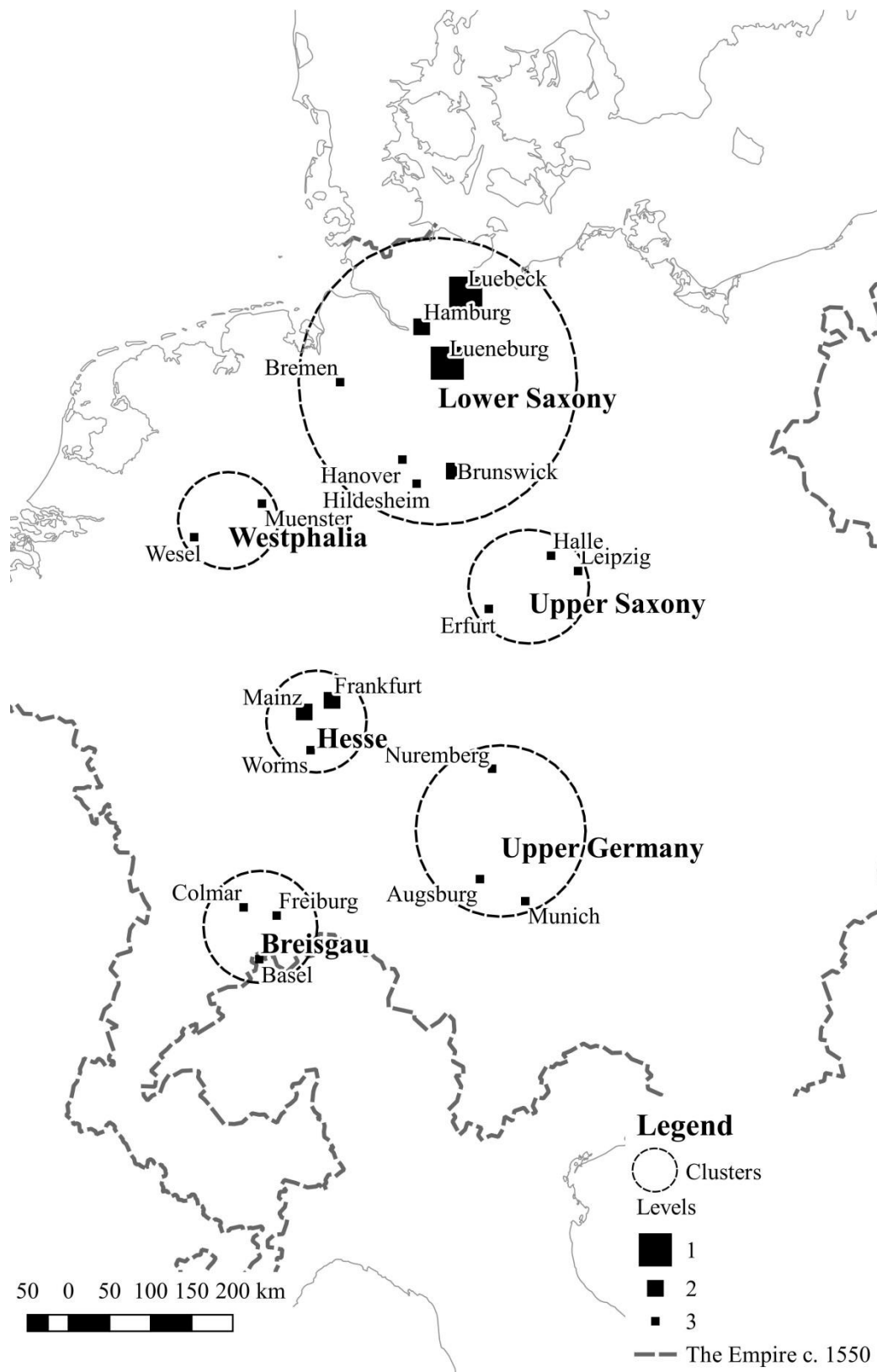
Sources: Online Appendix A.

Figure 5: Pairwise differentials by distance in the Empire: panel trends (logs)



Sources: Online Appendix A.

Figure 6: Capital market networks: clusters of cities



Sources: Online Appendix A.

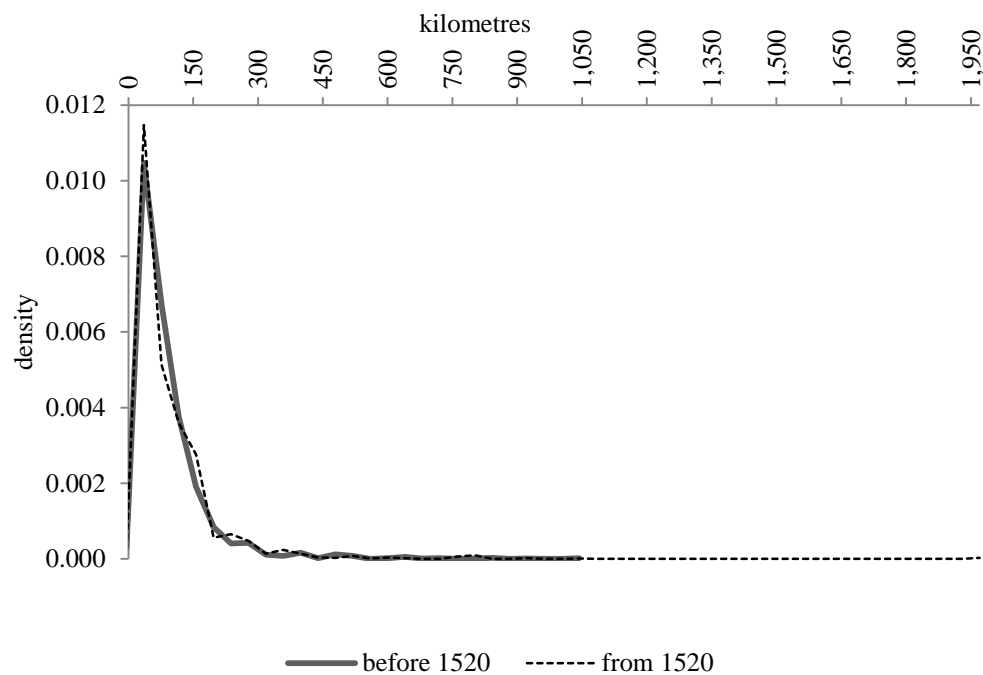
Figure B.1: Origins of foreign investors (12 cities sample)



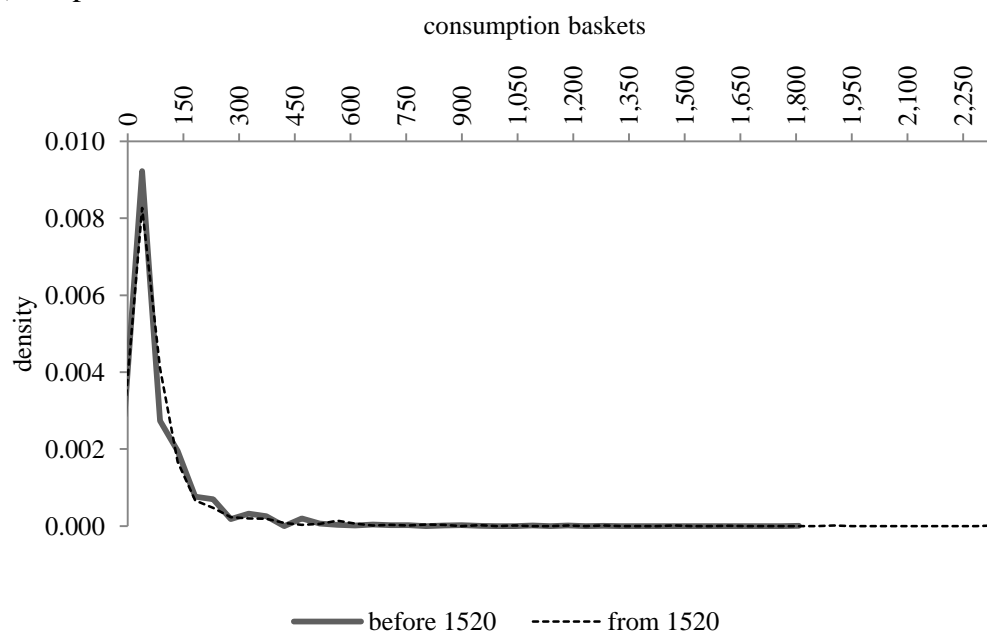
Sources: Online Appendix A.

Figure C.1: Inter-city investment in the Empire: the distribution of distance and capital before and after 1520

a) Distance

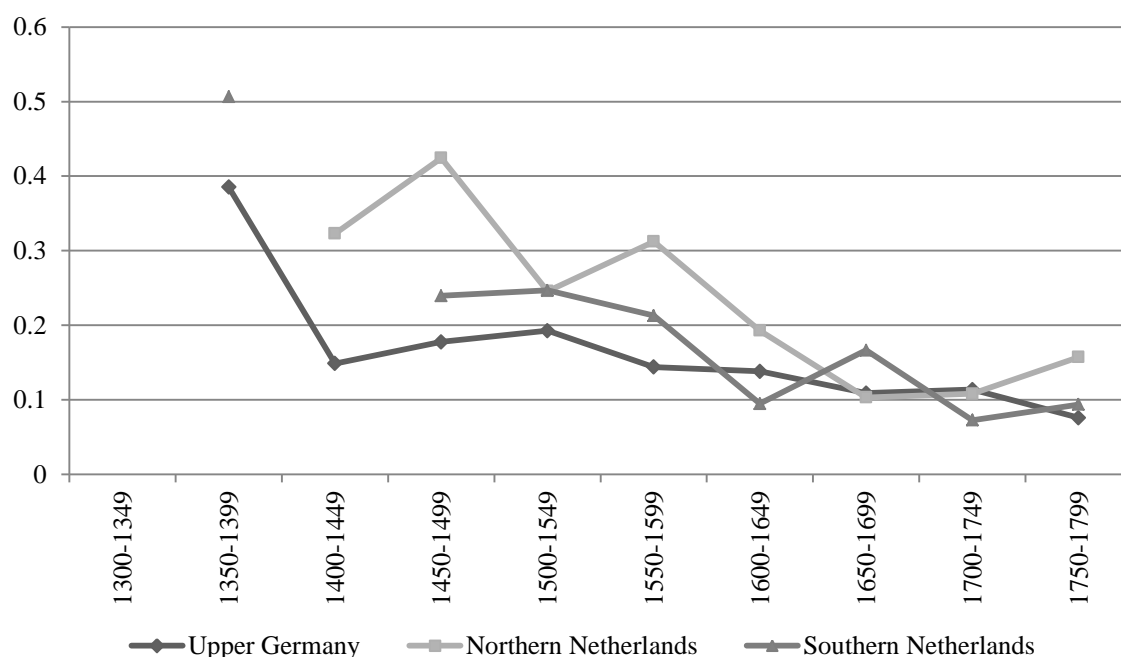


b) Capital



Sources: Online Appendix A.

Figure C.2: Integration between regions and the Empire as a whole: panel trends in dispersion around the mean (logs)



Sources: Online Appendix A.

¹ Related studies that, however, draw on a small number of interest rate observations and/or markets are Victoria Bateman (2012, p. 120) and Cyril Milhaud (2016). Bateman looks at a few scattered differentials in the cost of capital across Genoa, the Low Countries, England and Germany that suggest capital markets had been fairly well integrated already by the fifteenth century. Milhaud examines 88 private annuity contracts drawn up in 1725 and 1735 in the kingdoms of Castile and Aragon. He finds little capital movement between these territories and argues that this was an outcome of legal fragmentation. Michele Fratianni (2006, pp. 498-504) argues that early modern Genoa was well-integrated with other Italian and European markets, but finds large yield differentials with Naples and Antwerp. Larry Neal's (1985, 1987, 1994) analyses of capital

market integration in the eighteenth and nineteenth centuries focus on stock market prices and the major financial centres of the period.

- ² The term ‘Empire’ is used with reference to the Holy Roman Empire north of the Alps and, unless stated otherwise, includes also a few markets in eastern France close to the Empire’s border (see Figures 1 and 2 below).
- ³ Differences were on average 0.28 percentage points at a time when average interest rate were about 5 per cent (see Figure 2). This result is based on the comparison of 23 yields from the same place and year on the primary and the secondary markets. Data from Nuremberg, Hanover and Münster (1412-1680). Hanover City Archives, NAB 8242, p. 127/3 & 202/2, 441/1; Münster City Archives A IX 139 & 392, 393 & 395; State Archives Nuremberg, Bestand Losungsamt, vol. 69, fol. 66v, 80v, 81v, 91r, 133v, 217r, 219r, 220r, 222r; vol. 70, fol. 9r-v, 11r, 93v, 106r, 109r, 115v, 117r, 121r. On the development of secondary markets in late medieval Germany see Hans-Jörg Gilomen (1984, pp. 193-201).
- ⁴ This tallies with Alberto Feenstra (2014, pp. 15-16), who finds that for bonds issued by the Dutch province of Zeeland in the second half of the eighteenth century, the secondary market yields were very close to the official rates.
- ⁵ Focusing on official rates and the primary market implies not controlling for mark-ups for mostly local primary buyers, but this produces a similar bias against our results. Within early modern Italy there is fairly strong evidence of mark-ups in Venice and especially Genoa (cf. Chilosì 2014, pp. 909-10). However, in Genoa, not only were secondary prices unusually high, but also nominal rates were exceptionally low. Thus if we used secondary market yields, which do not include rents enjoyed by primary buyers, the differentials between Genoa and the other Italian cities would be even higher than those we observe.
- ⁶ To be clear, the data do *not* include commercial loans that may have been tied to commodity trade. We discuss a potential link between commodity trade and capital market integration below (p. 21).
- ⁷ Available at <https://www.nuffield.ox.ac.uk/People/sites/Allen/SitePages/Biography.aspx> (accessed 16/11/16).

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- ⁸ When we could not precisely measure the difference, we excluded the relevant observations. In Nuremberg, the ratio of taxed over untaxed rates was stable at around 1:1.21 only between 1490 and 1500. In Brunswick, some life annuities were exempt from taxation and other civic burdens, but this had a negligible impact on interest rates.
- ⁹ The analysis is based on 12 cities with at least 80 observations on the origin of foreign investors; see map in Figure B.1, Online Appendix B. The network distance (the average number of links one needed to pass to reach another node) for the same sample is 1.6, after excluding Leiden which had only indirect links (through Amsterdam) with the main network. This number also signals a dense network: Most cities were connected either directly or through a third place.
- ¹⁰ While Chambery is beyond the Alps, it belonged to Savoy. Thus, the data for Chambery are used to investigate patterns of capital integration both in Italy and north of the Alps.
- ¹¹ The results are robust to controlling for potential bias due to composition effects by including fixed effects. The rates paid on life annuities show a similar pattern.
- ¹² Figure 3 draws on at least ten observations per decade as minimum threshold for inclusion. On average, 63 observations per decade are available.
- ¹³ A place is considered to belong to the hinterland of the closest other place that had at least 5000 inhabitants at some point in time during the period covered here (1228 to 1802). There are 670 observations referring to villages within the hinterlands of our cities; the average distance from the city is 20 km; the maximum is 56 km.
- ¹⁴ The consumption basket is based on price data from Strasbourg which are the most comprehensive of all price series available for the Empire (1326-1875). We used a smoothed trend obtained with an Epanechnikov kernel for the conversions. To avoid boundary problems, London price data have been used for extrapolating the series backwards to 1264, the first year London prices are available for. Both the Strasbourg and the London price indices are from the Robert Allen (2001) database.

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- ¹⁵ As distances and volumes of inter-city investments are much more volatile than interest rate differentials, more observations are needed to produce reliable estimates, which is why 50-years rather than 10-years dummies are used here. For distance, there are only 18 means in 1700-1749 and 8 means in 1750-1799 as compared to 68 in 1650-1699 and 297 in 1550-1599.
- ¹⁶ The case of Augsburg illustrates the effects of the war on both the local supply of and demand for capital; see Bernd Roeck (1991, pp. 270-283).
- ¹⁷ There are 2,545 observations from before 1520 and 1,998 from the years thereafter.
- ¹⁸ For a graphical exposition, see Figure C.1, Online Appendix C.
- ¹⁹ To make good use of the available interest rates data, here and in the subsequent analysis we extrapolate missing years from the heritable annuities' series on the basis of the rates paid on life annuities in the same place at around the same time. Normalising yields on securities with different terms to maturity is standard practice in financial history (e.g. Flandreau and Flores 2009; Chilosì 2014). This is a safe procedure for the data from around the mid-fifteenth century when pricing became systematic and less subject to idiosyncrasy. In addition, we linearly interpolate missing observations when both the adjacent years are covered. Such interpolations are expected to be very precise, given that the series exhibit very little volatility. In these ways we augment the overall sample of yearly means by about 12 per cent. Reassuringly, the overall trends detected by the heritable annuity and the augmented samples are identical.
- ²⁰ The cities not shown in the figure are Osnabrück, Soest, Schaffhausen, Memmingen, Vienna, Wismar and Würzburg.
- ²¹ On the relationship between commodity trade and capital market integration see p. 23 below.
- ²² Node degree analysis also finds that capital markets were particularly developed in Lübeck (before 1520) and Hamburg (from 1520), even after econometrically controlling for sample bias.
- ²³ The few available data on capital movements suggest only weak links between these regions as well as between them and the rest of the Empire. We therefore treat the cities in the Northern Netherlands as a cluster in its own right. Considering that clusters typically formed around important financial centres and

that Antwerp and Bruges were such centres (e.g. Munro 2003, pp. 541-42), we define the Southern Netherlands, including the other cities in Brabant, Flanders and Northern France, as another cluster.

‘Northern France’ consists of Amiens, Arras, Douai, Lille, St. Quentin and Paris. All these cities except Paris were at some point ruled by Burgundy.

²⁴ See Figure C.2, Online Appendix C, on the three clusters driving convergence.

²⁵ Wheat markets, for example, were much better integrated in Italy than in Central Europe (Federico, Schulze and Volckart, mimeo 2018).

²⁶ For example, on 14 March 1599 the Florentine Senate stated that ‘buyers ... can be ... subjects as well as foreigners ... of whatever fate, grade or condition’ (Archivio di Stato di Firenze, Monte Comune o delle Graticole, parte I, pezzo 3, p. 261).

²⁷ Contemporaries noted the advantages of the Empire’s constitutional arrangements. Thus, Edward Brown (1677, p. 65), an English physician travelling through Germany in 1668, argued that through the Imperial Diet ‘the great Concerns of *Germany* are much secured, and their peace and quiet Established. Wherein *Germany* seems to have a better advantage than *Italy*; For *Italy* being likewise divided into many Dominions and Principalities, hath no common Diet or Great Council, whereby to proceed for their Publick safety: Which makes them often divided in their common Concerns...’.

²⁸ Staatsarchiv Nürnberg, Bestand Losungsamt Vol. 69, fol. 21 r (no.117), 26 v (no. 136), 28r (no. 137), Stadtarchiv Hannover, NAB 7228, fol. 19 v; Zijderduijn (2009, pp. 113-15).

²⁹ Regionaal Archief Dordrecht (formerly ‘Gemeente Archief Dordrecht’), GAD 1, no. 434, fol. 50v-53r, Stadtarchiv Braunschweig, B I 11 Leibgedingebücher, vol. 4, fol. 36v-39r), Stadtarchiv Hannover, NAB 8242, Stadtobligationsbuch 1387-1533, 108/2, 110/1, 118/12, 130/1, 137/3, 140/2, 141/4, 156/1, 163/2, 164/2, 177/1, 184/1, 192/1, 197/1, 227/3, 267/2, 268/1, 275/1, 284/1, 287/2, 364/2, 434/1, 437/2, 542/2, 554/2, 571/2, 755/1; NAB Nr. 7228 p.2; Urkunden Abteilung 3 - Schuldurkunden des Rates, nos. 43, 46, 51, 55, 56, 57, 60, 132, 172, 248, 269, 275, 293, 298, 307, 309, 310, 314, 315, 317, 318, 321, 323, 334, 340,

342, 346, 347, 350, 354, 357, 358, 361, 363, 366, 367, 373, 537, Albers (1930, pp. 49-50), Zuijderduijn (2009, p. 115).

- ³⁰ Stadtarchiv Hannover, NAB 8242, Stadtobligationsbuch (1387-1533), 118/12; Abteilung 3 - Schuldurkunden des Rates nos. 43, 46, 51, 57; Staatsarchiv Nürnberg, Bestand: Losungsamt, vol. 69, fol. 97r-v (no. 444), 98r (no. 447), 99r (no. 450), 103r (no. 468), 112r (nos. 499-500), 126r (no. 567); vol. 70, fol. 125r (no. 386); Stadtarchiv Erfurt, 1-1/21 10 Libri ordinationum, vol. 1, fol. 1v, 8v; 1-1/21-12/1 Obligationen, 70ff, 75ff, 147ff; 1-1/22, 2 Hauptrechnungen no. 1, 0-1/ 4- 121 (1); Stadtarchiv Lüneburg, AB 55 Kopie von Rentenbriefen (1441-1492), fol. 20r, 76r f., 90r, 93r-94r, 98v f; Landeshauptarchiv Magdeburg, Copiar der Obligationen der Stadt Halle, Cop. 395a, fol. 27v, 29v, 38v, 315r; Cop. 396, fol. 30r, 131r, 134v, 159r; Klinger (2011, pp. 336-38); Archives de la ville Strasbourg, Série IV No. 71, p. 148; Stadtarchiv Münster, Ratsarchiv A IX, Findbuch zu den Rentenverschreibungen aus Abt. A IX des ‚Alten Archivs‘, no. 43.